US010809492B2

(12) United States Patent
Chang et al.

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(45) Date of Patent: *Oct. 20, 2020

(54) OPTICAL IMAGE CAPTURING MODULE

(71) Applicant: **Ability Opto-Electronics Technology Co. Ltd.**, Taichung (TW)

(72) Inventors: **Yeong-Ming Chang**, Taichung (TW); **Chien-Hsun Lai**, Taichung (TW); **Yao-Wei Liu**, Taichung (TW)

(73) Assignee: **Ability Opto-Electronics Technology Co., Ltd.**, Taichung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/232,663**

(22) Filed: **Dec. 26, 2018**

(65) **Prior Publication Data**

US 2020/0057252 A1 Feb. 20, 2020

(30) **Foreign Application Priority Data**

Aug. 16, 2018 (TW) .... 107128612 A

(51) **Int. Cl.**

G02B 13/00 (2006.01)
H04N 5/232 (2006.01)
G02B 7/08 (2006.01)

(52) **U.S. Cl.**

CPC ***G02B 13/001*** (2013.01); ***G02B 7/08*** (2013.01); ***H04N 5/23212*** (2013.01)

(58) **Field of Classification Search**

CPC . G02B 7/021; G02B 9/34; G02B 9/64; G02B 9/62; G02B 9/60; G02B 7/006; G02B 5/208; G02B 7/09; G02B 13/001; G02B 7/08; H04N 5/2258; H04N 5/2254; H04N 5/2253; H04N 9/045; H04N 5/23212; G03B 11/00; G03B 13/36

See application file for complete search history.

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(Continued)

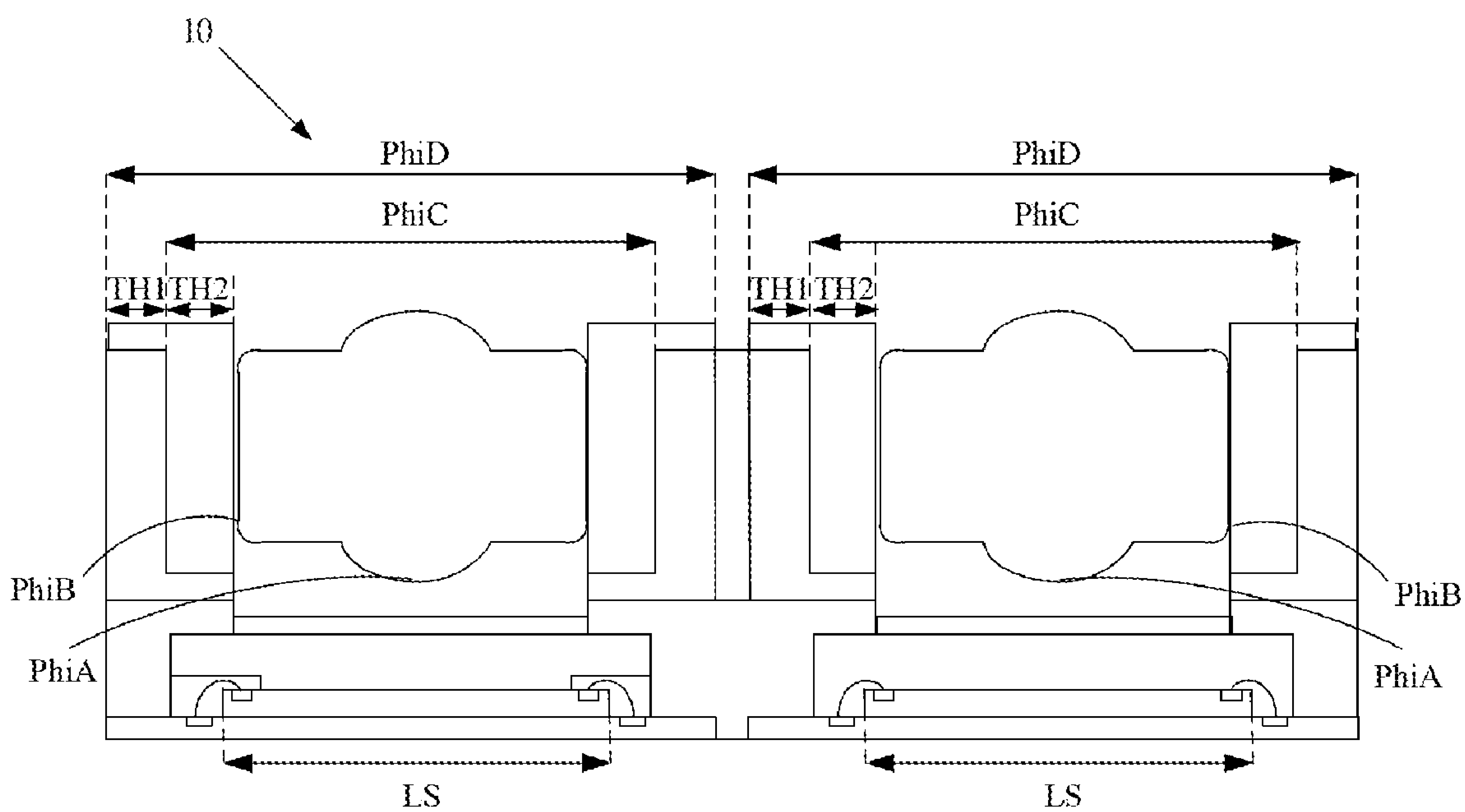
Primary Examiner — Chiawei Chen

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

An optical image capturing module is provided, including a circuit assembly and a lens assembly. The circuit assembly may include a circuit substrate, a plurality of image sensor elements, a plurality of signal transmission elements, and a multi-lens frame. The image sensor elements may be connected to the circuit substrate. The signal transmission elements may be electrically connected between the circuit substrate and the image sensor elements. The multi-lens frame may be manufactured integrally and covered on the circuit substrate and the image sensor elements. A part of the signal transmission elements may be embedded in the multi-lens frame, whereas the other part may be surrounded by the multi-lens frame. The lens assembly may include a lens base and a fixed-focus lens assembly. The lens base may be fixed to a multi-lens frame. The fixed-focus lens assembly may have at least two lenses with refractive power.

31 Claims, 34 Drawing Sheets



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* cited by examiner

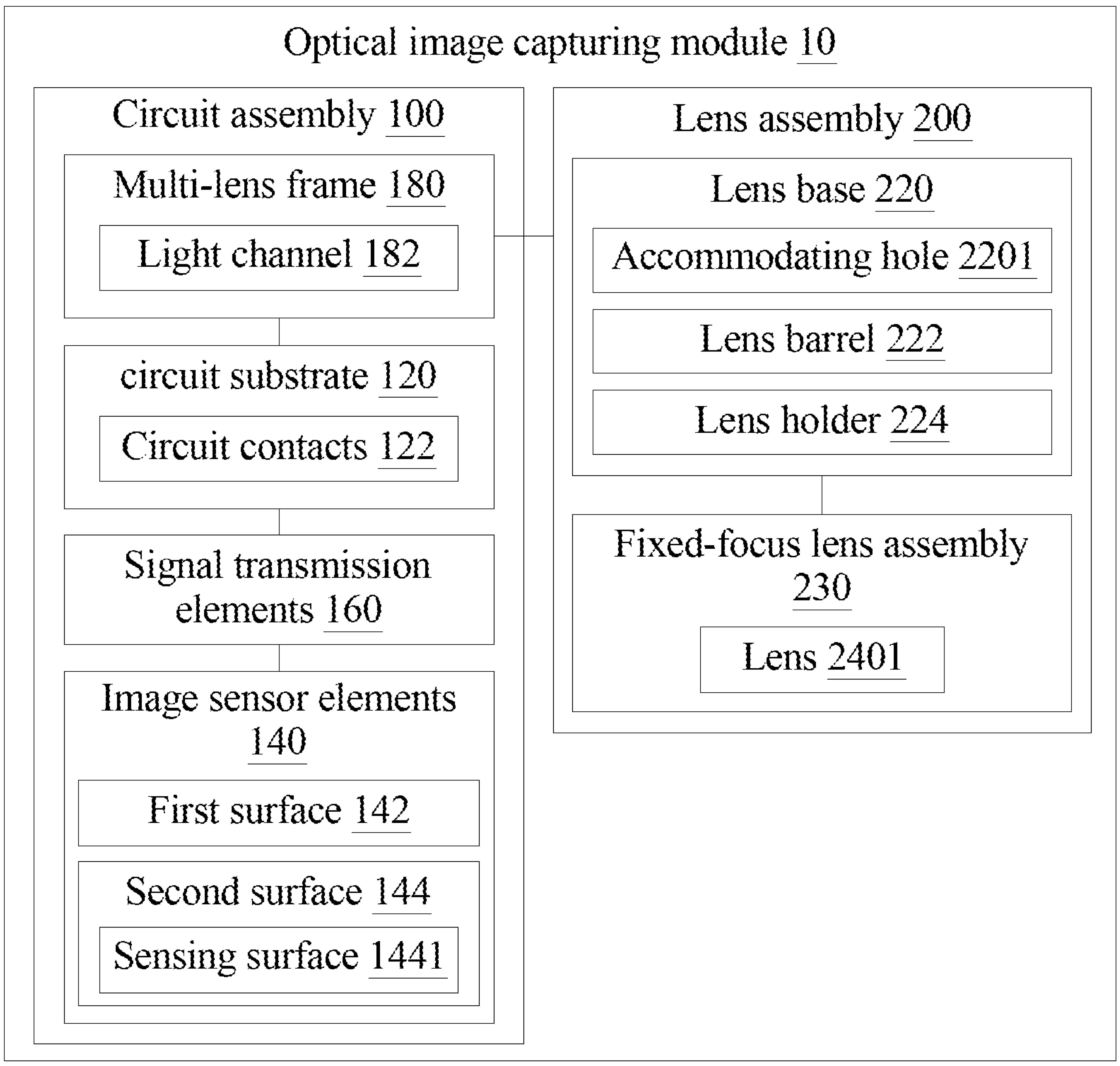
Optical image capturing module 10
Circuit assembly 100
Multi-lens frame 180
Light channel 182
circuit substrate 120
Circuit contacts 122
Signal transmission elements 160
Image sensor elements 140
First surface 142
Second surface 144
Sensing surface 1441
Lens assembly 200
Lens base 220
Accommodating hole 2201
Lens barrel 222
Lens holder 224
Fixed-focus lens assembly 230
Lens 2401

FIG. 1

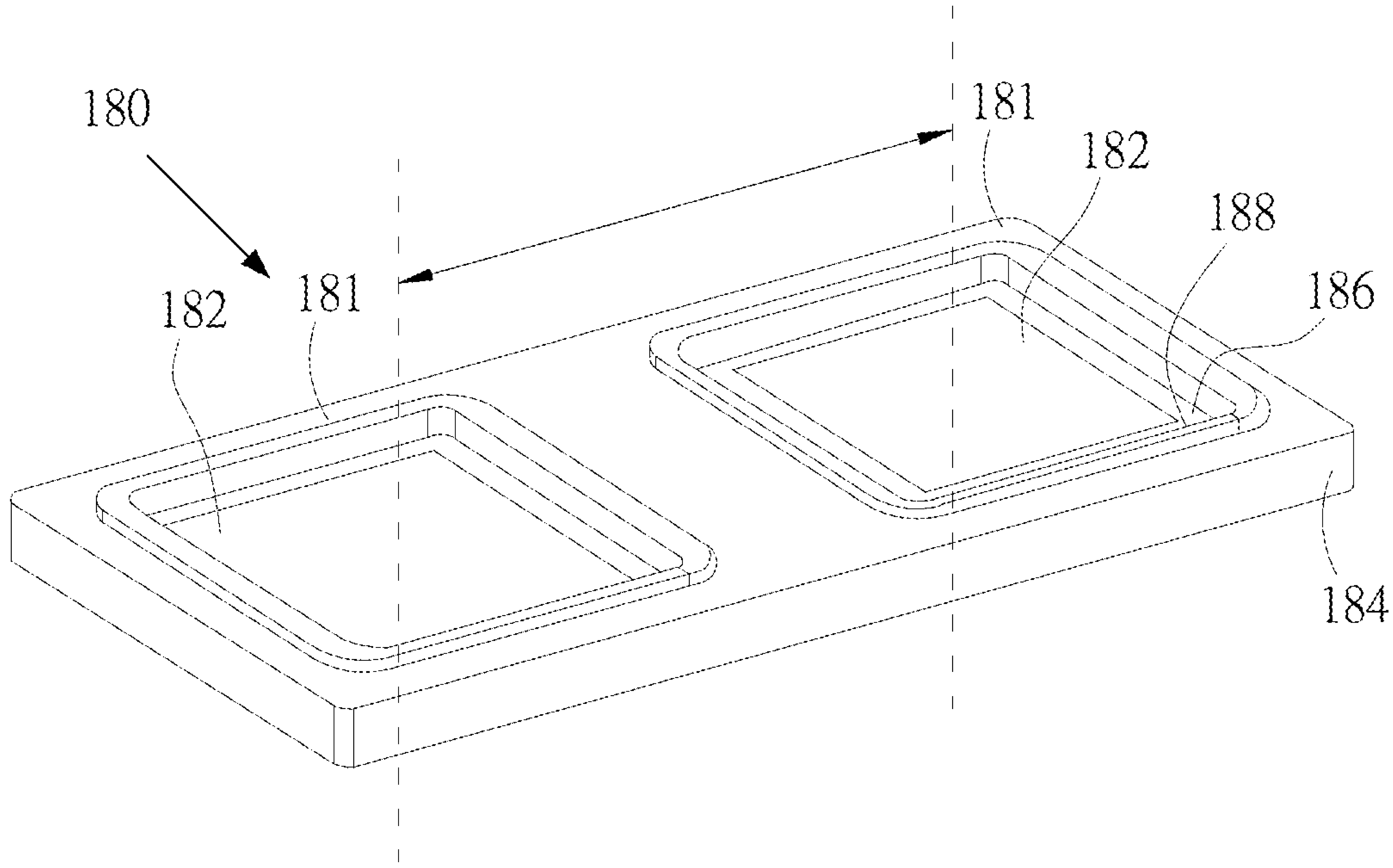
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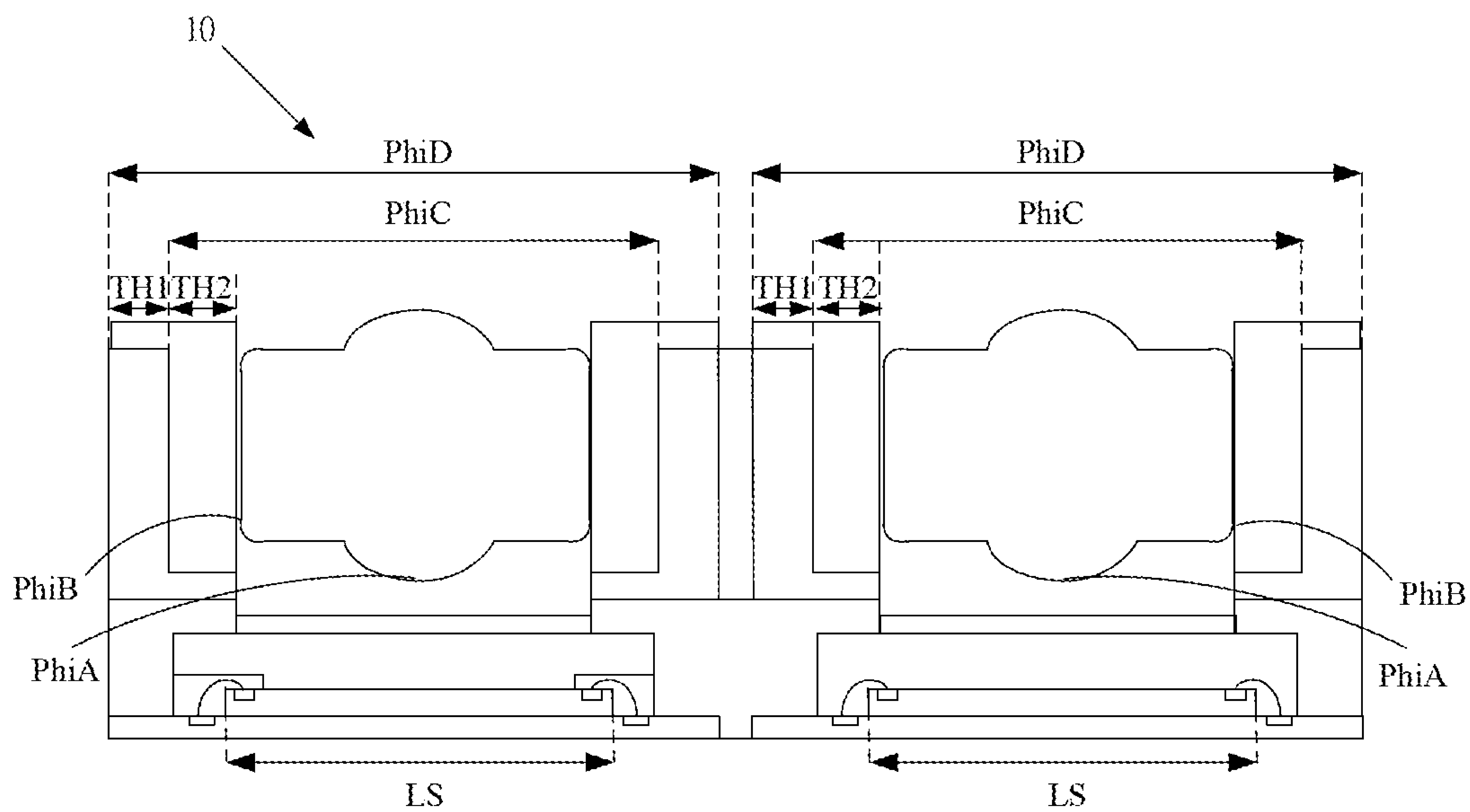
FIG. 2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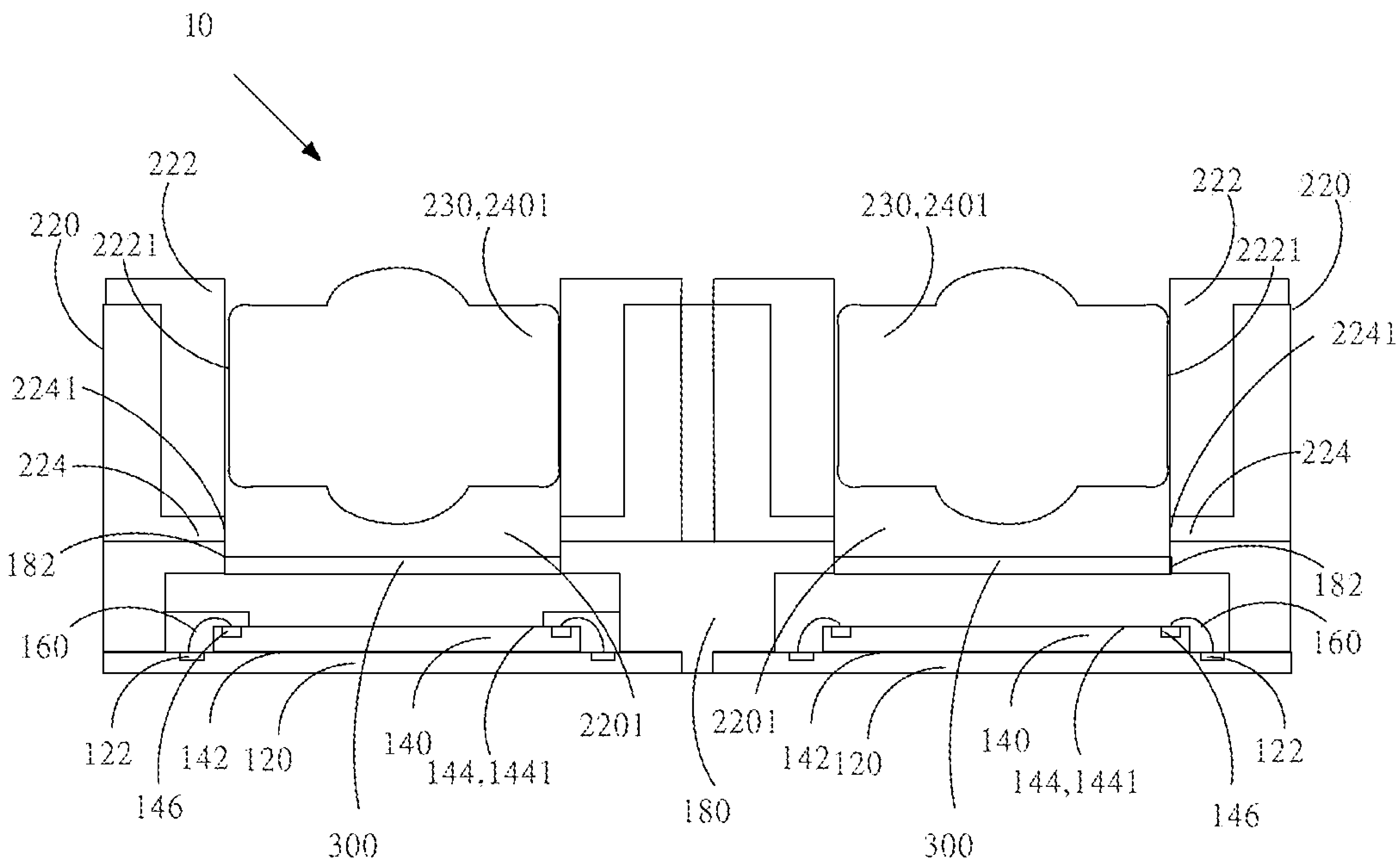
TH1
TH2
PhiB
PhiA
PhiB
PhiA
LS
LS

FIG. 3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122
142
120
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2201
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142
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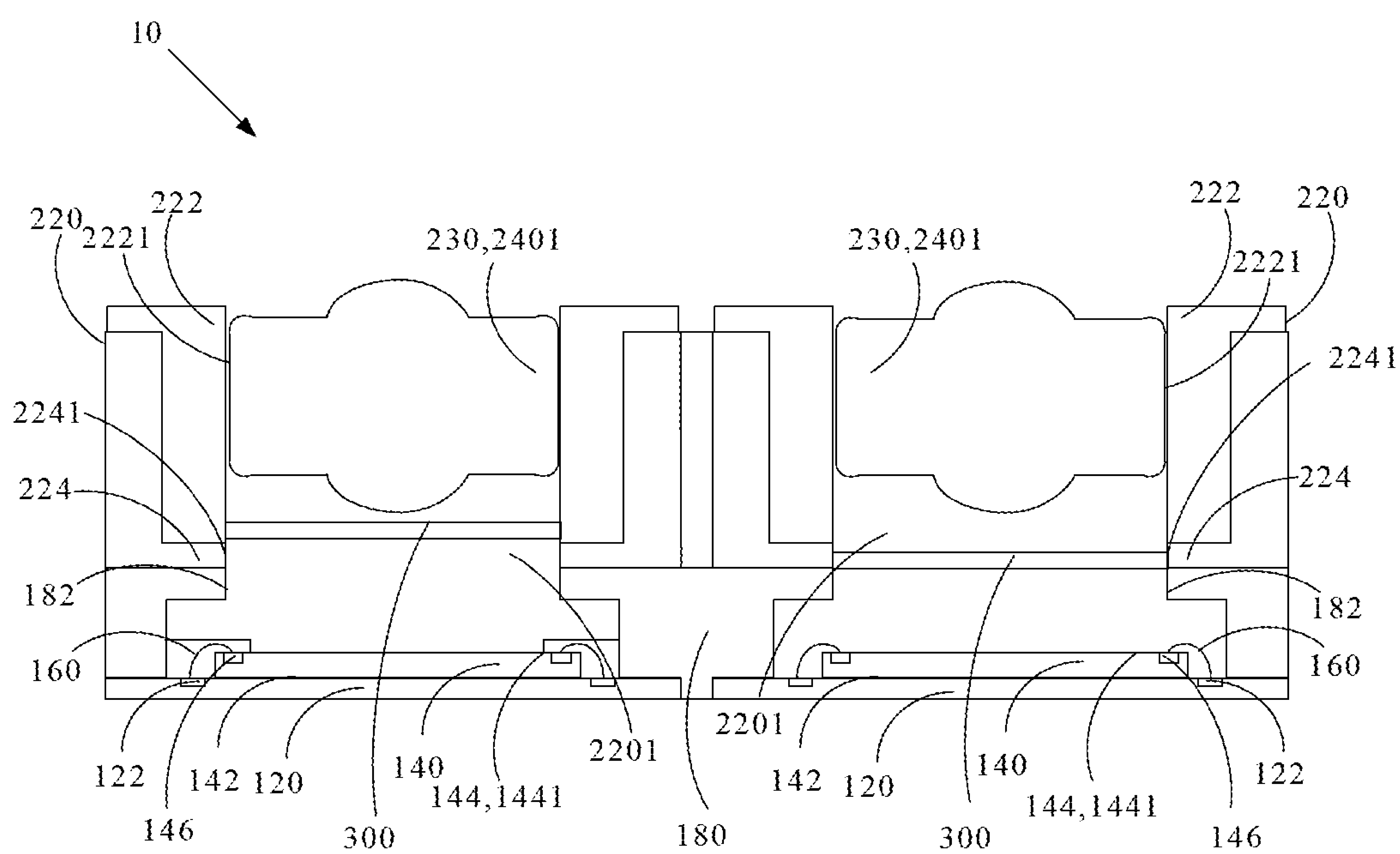
140
144,1441
122
146
180
146
300
300

FIG. 4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122
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120
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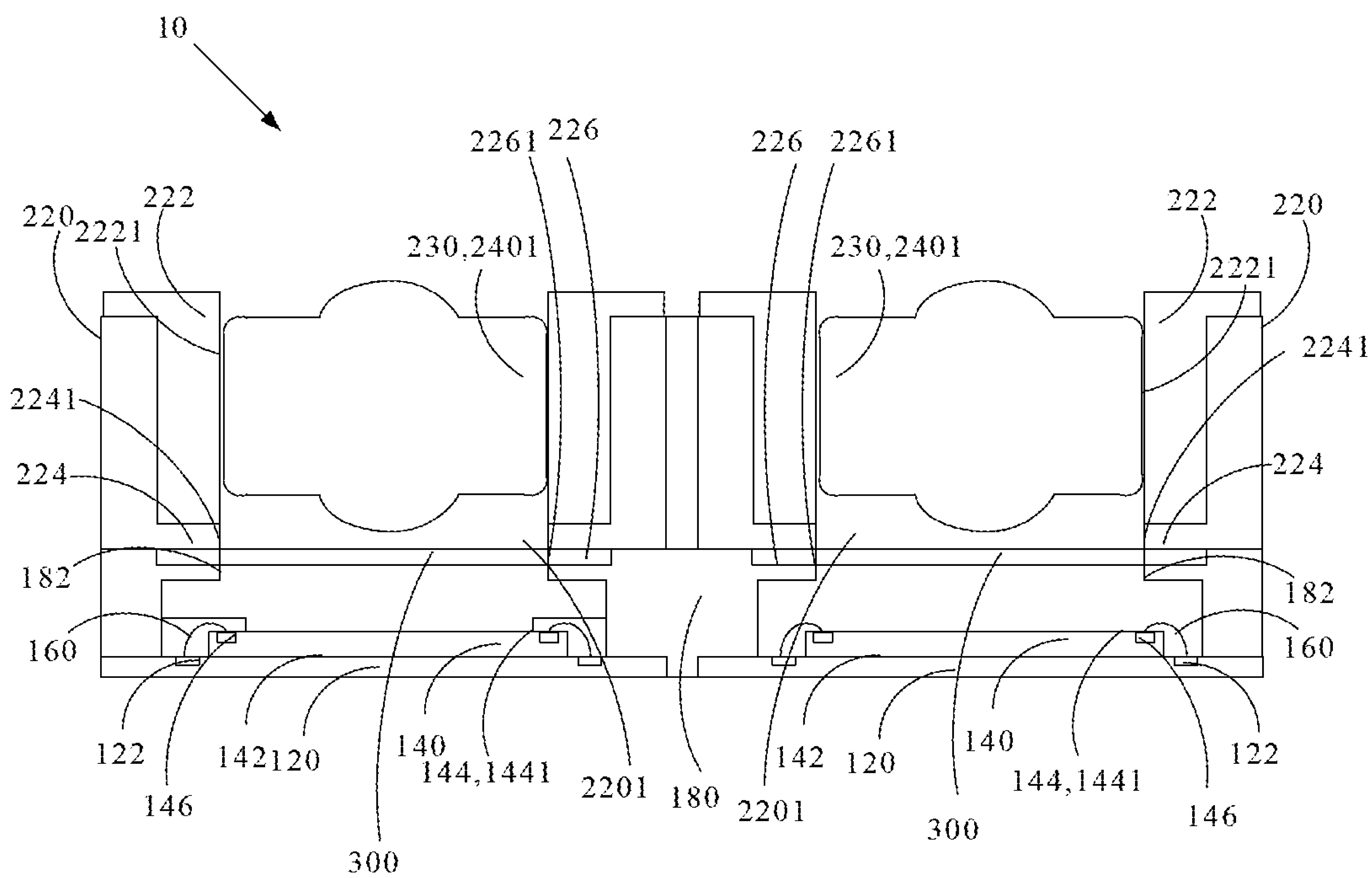
144,1441
122
146
300
180
300
146

FIG. 5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2241
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122
142
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144,1441
2201
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144,1441
146
122
146
300
300
146

FIG. 6

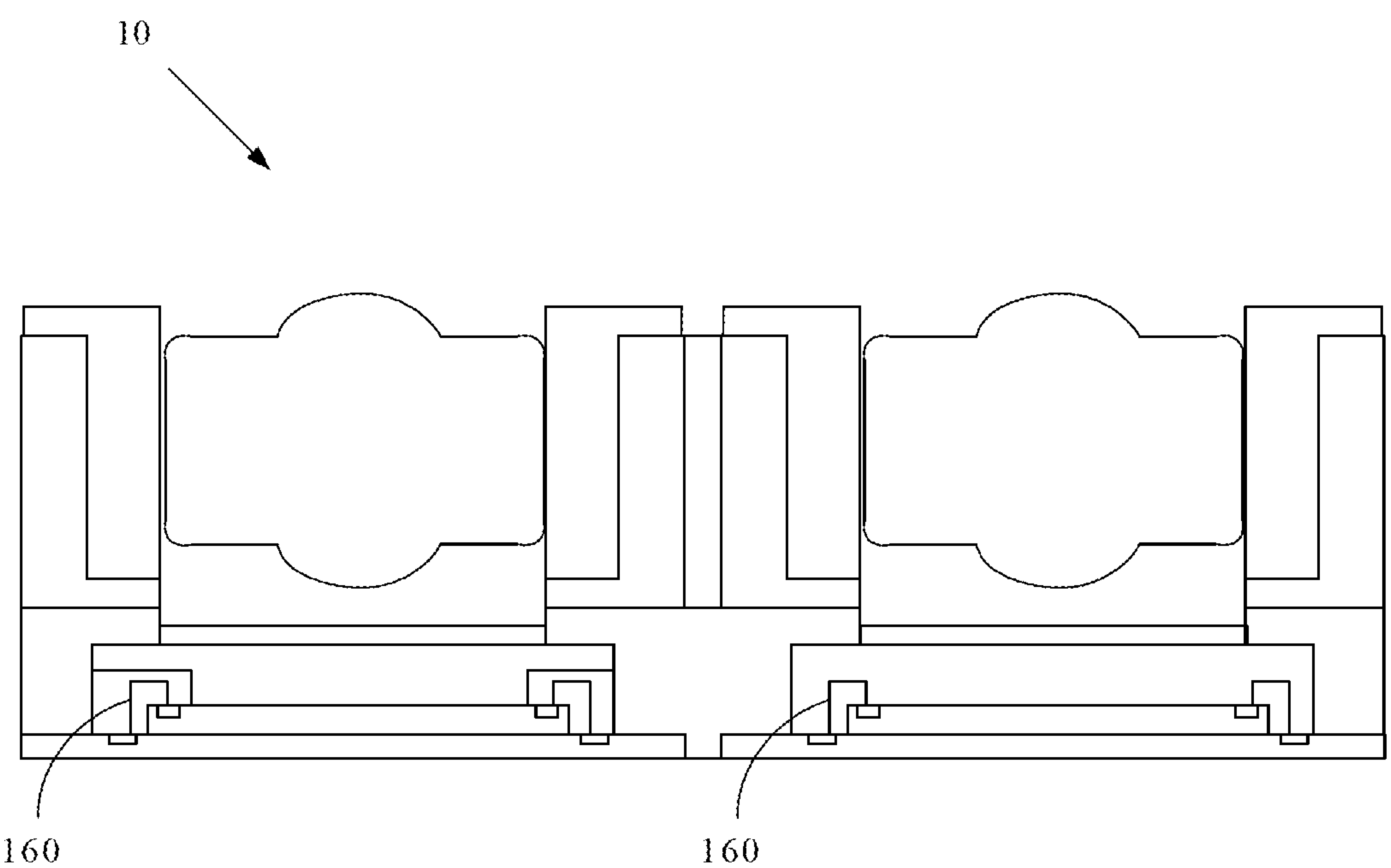
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FIG. 7

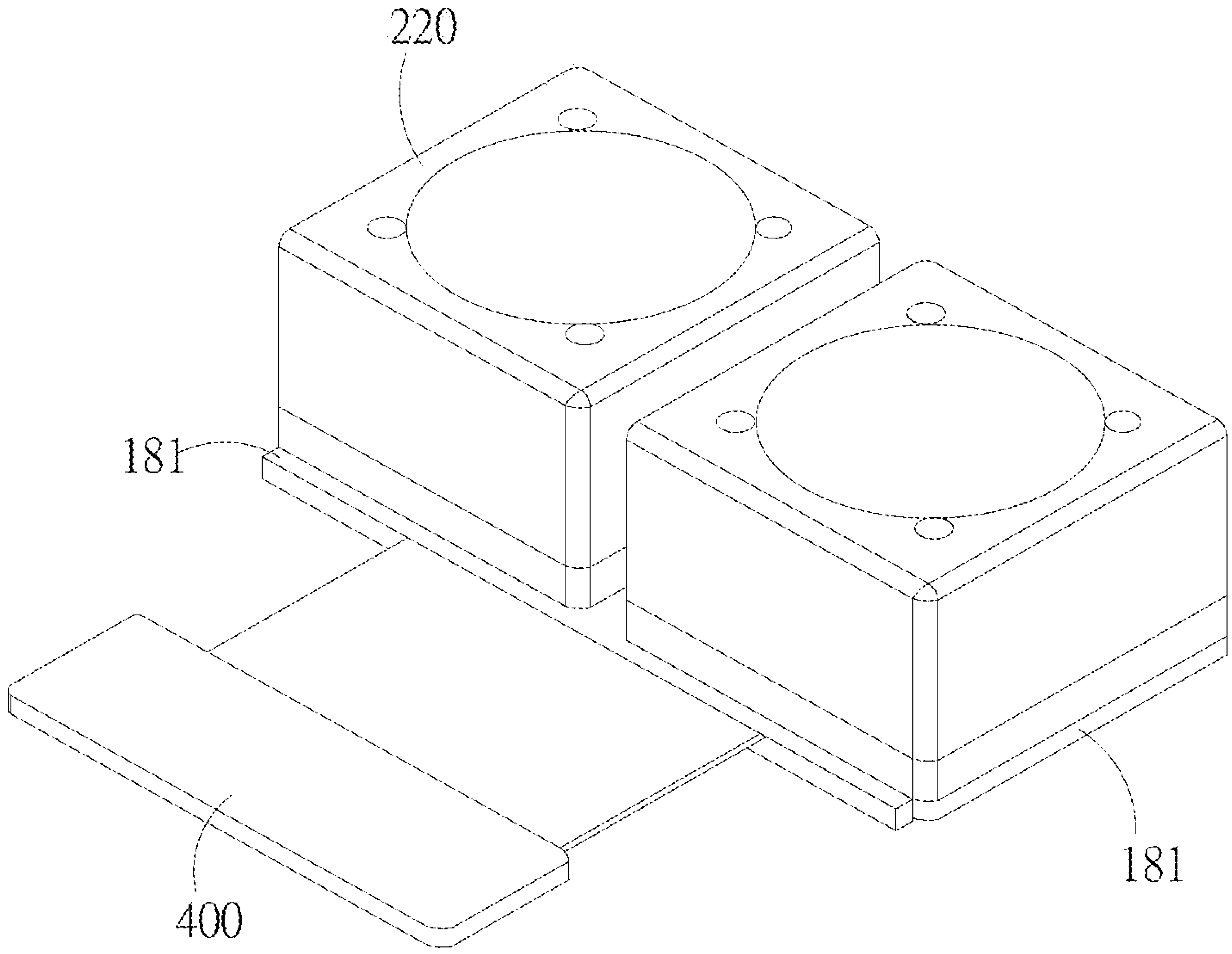


FIG. 8

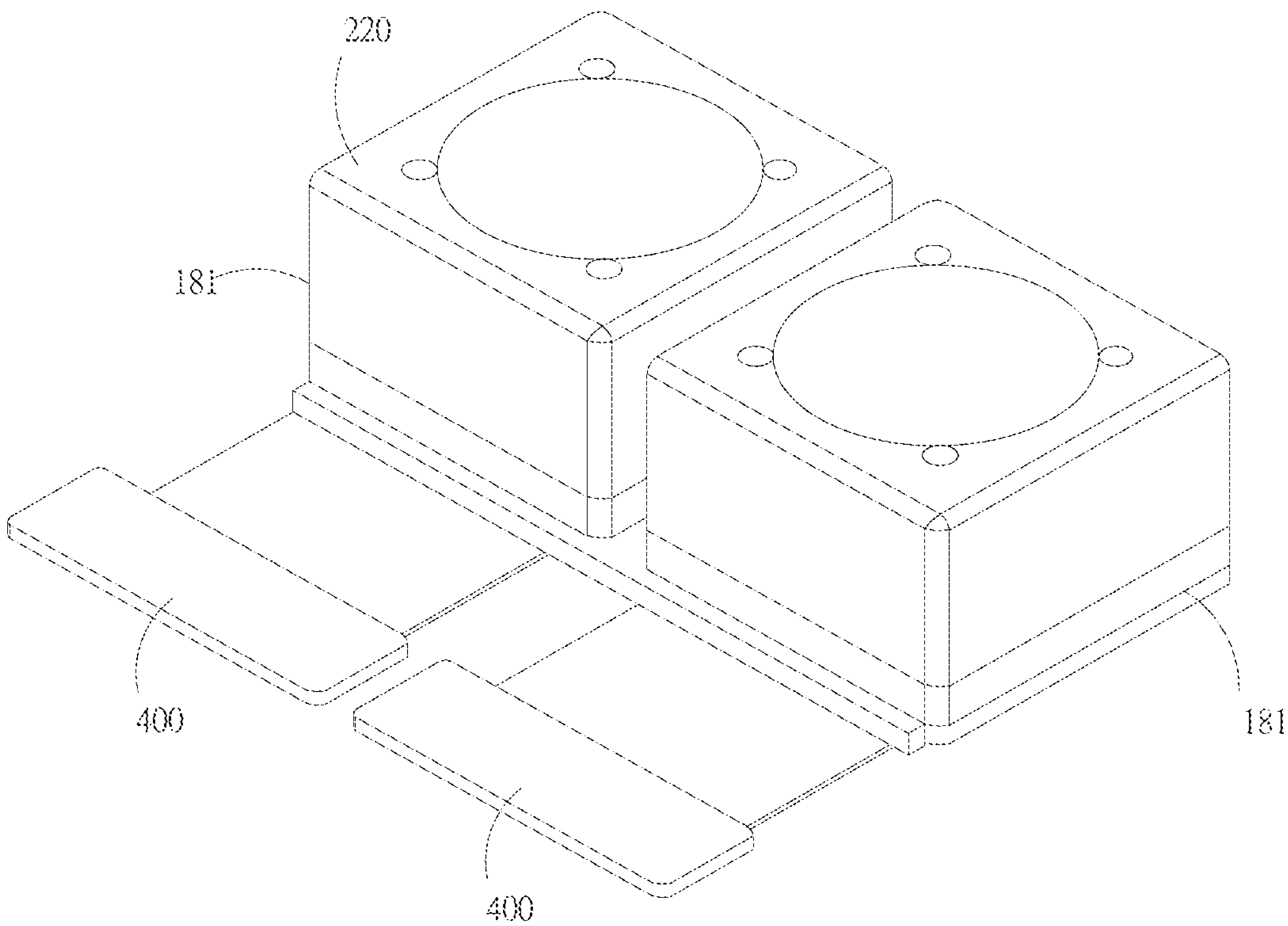


FIG. 9

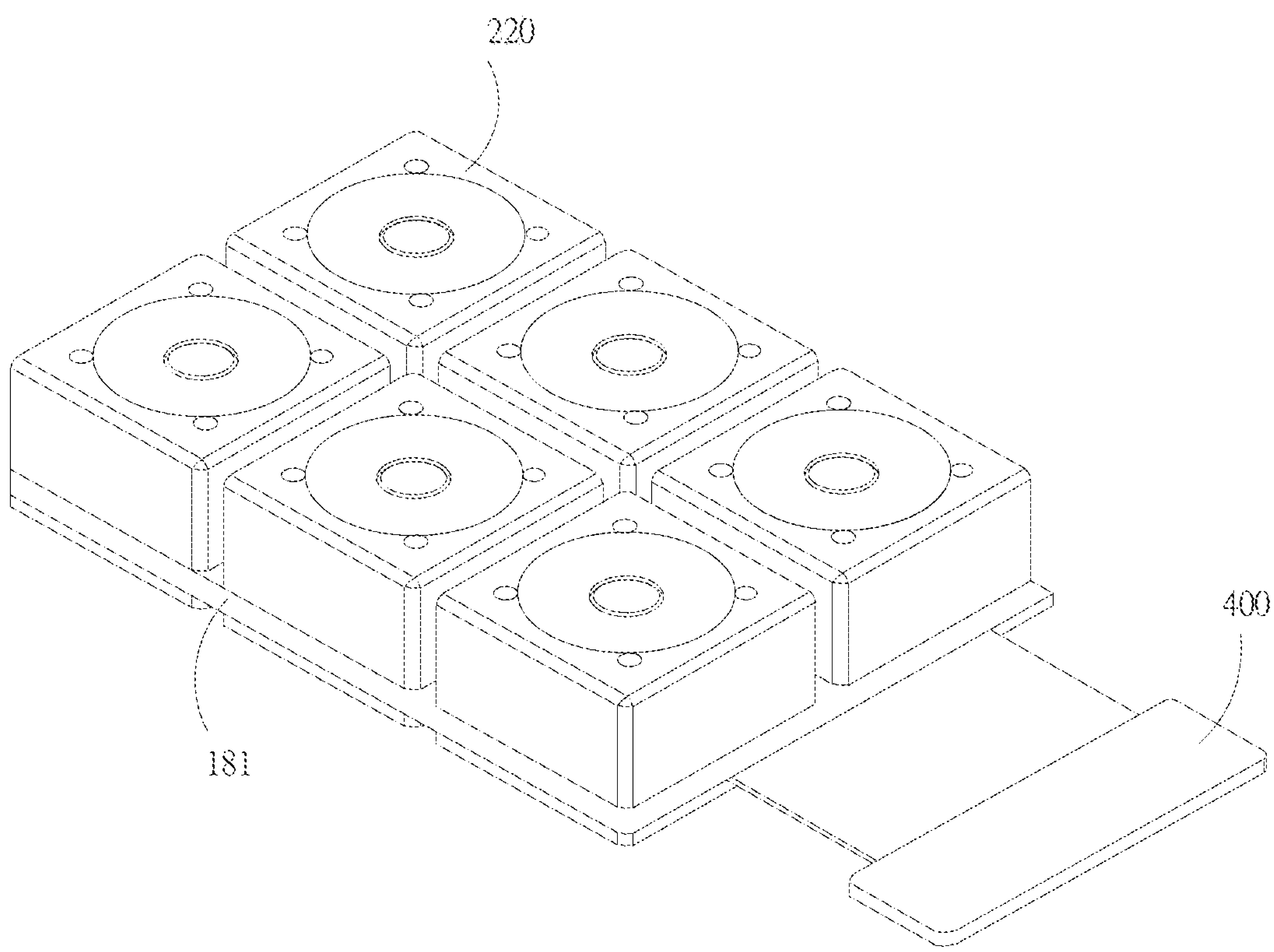


FIG. 10

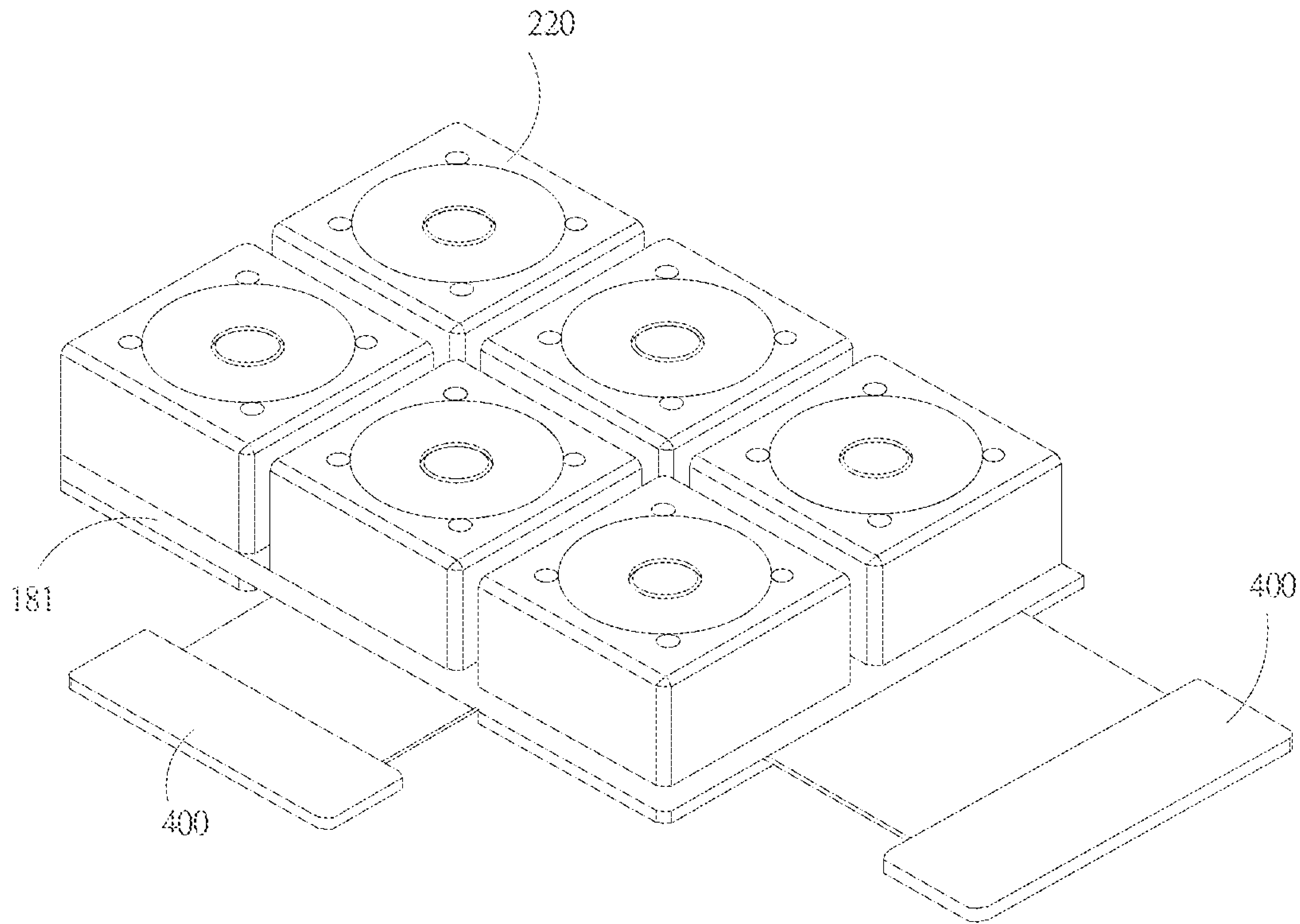
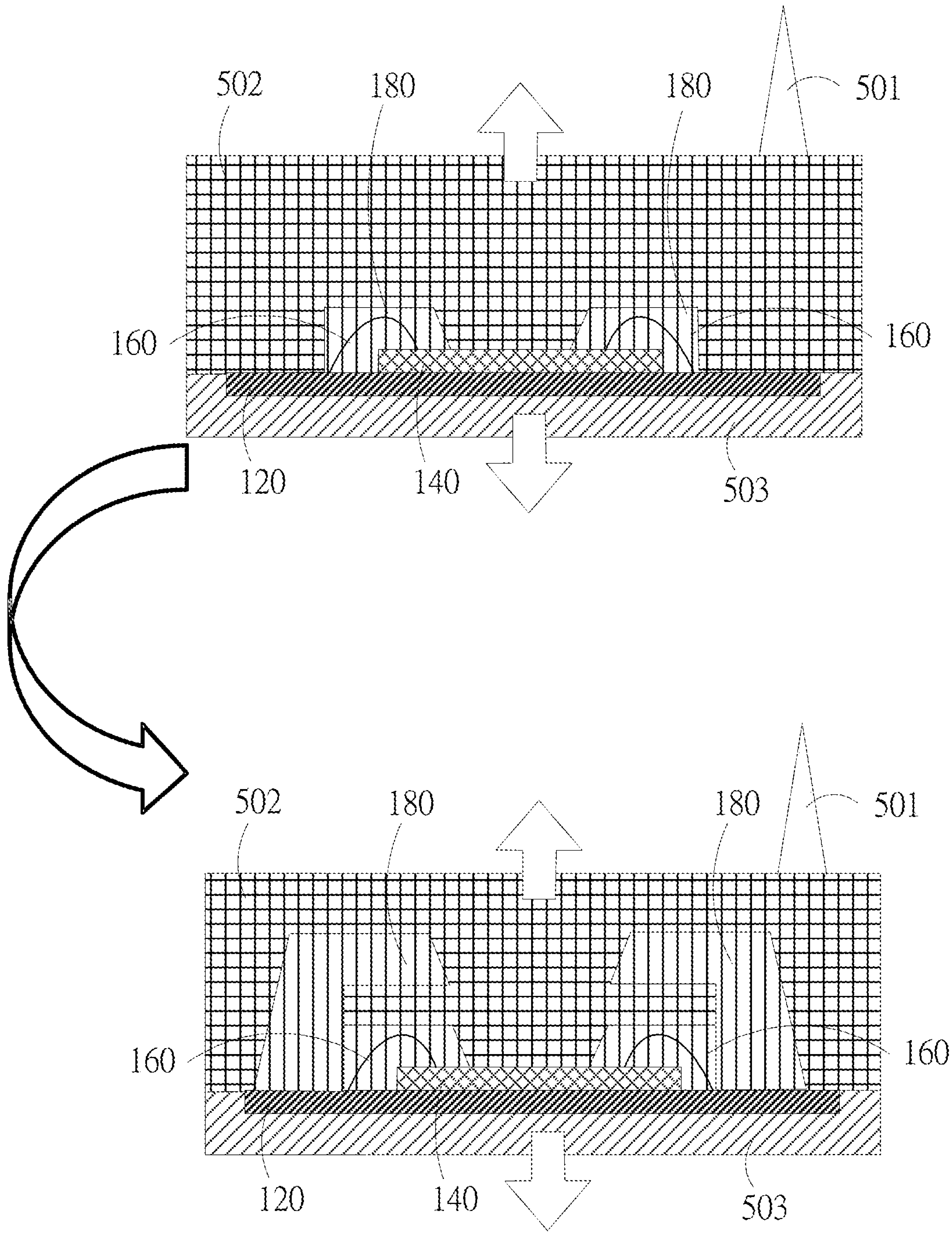


FIG. 11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503
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120
140
503

FIG. 12

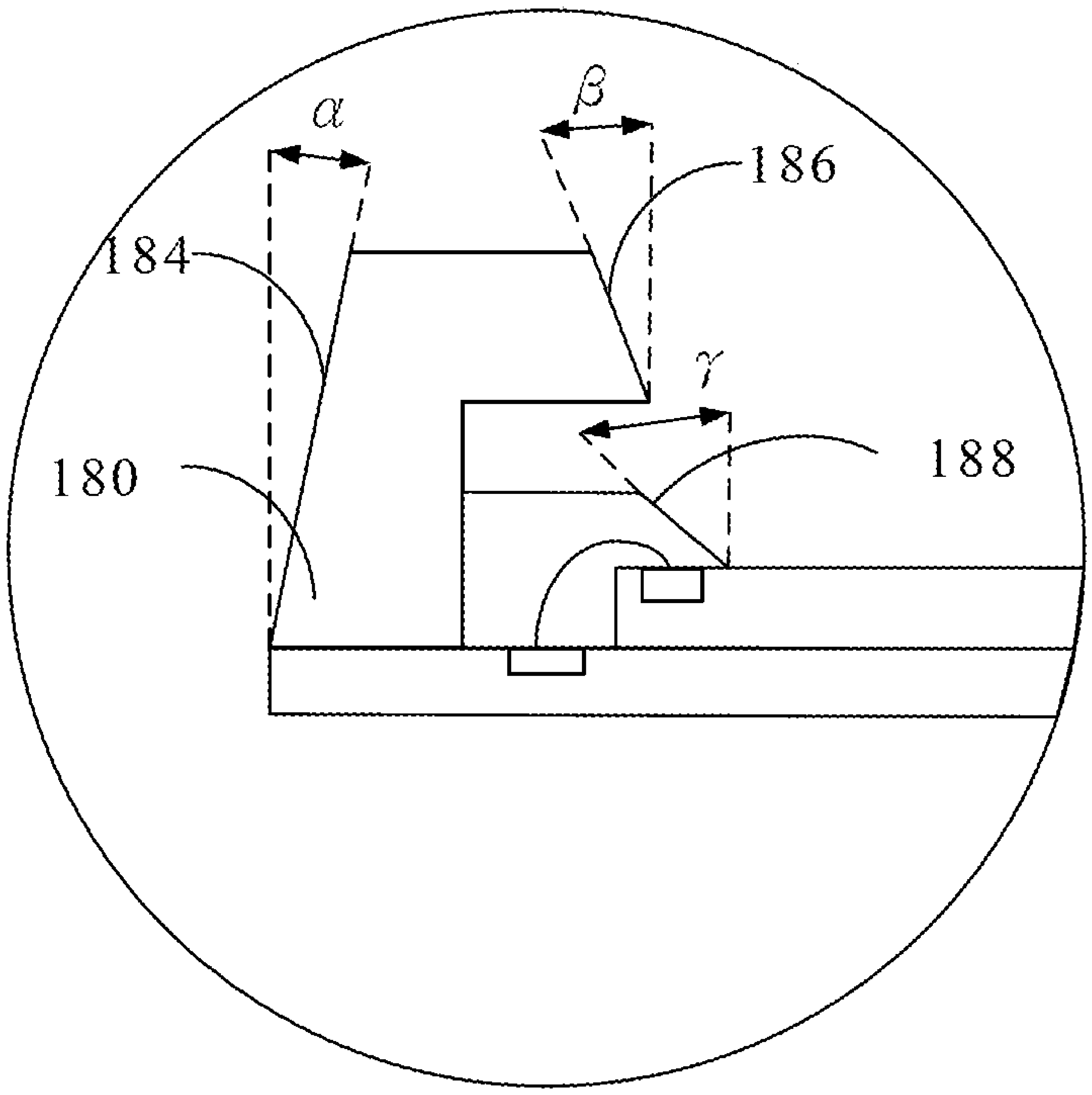


FIG. 13

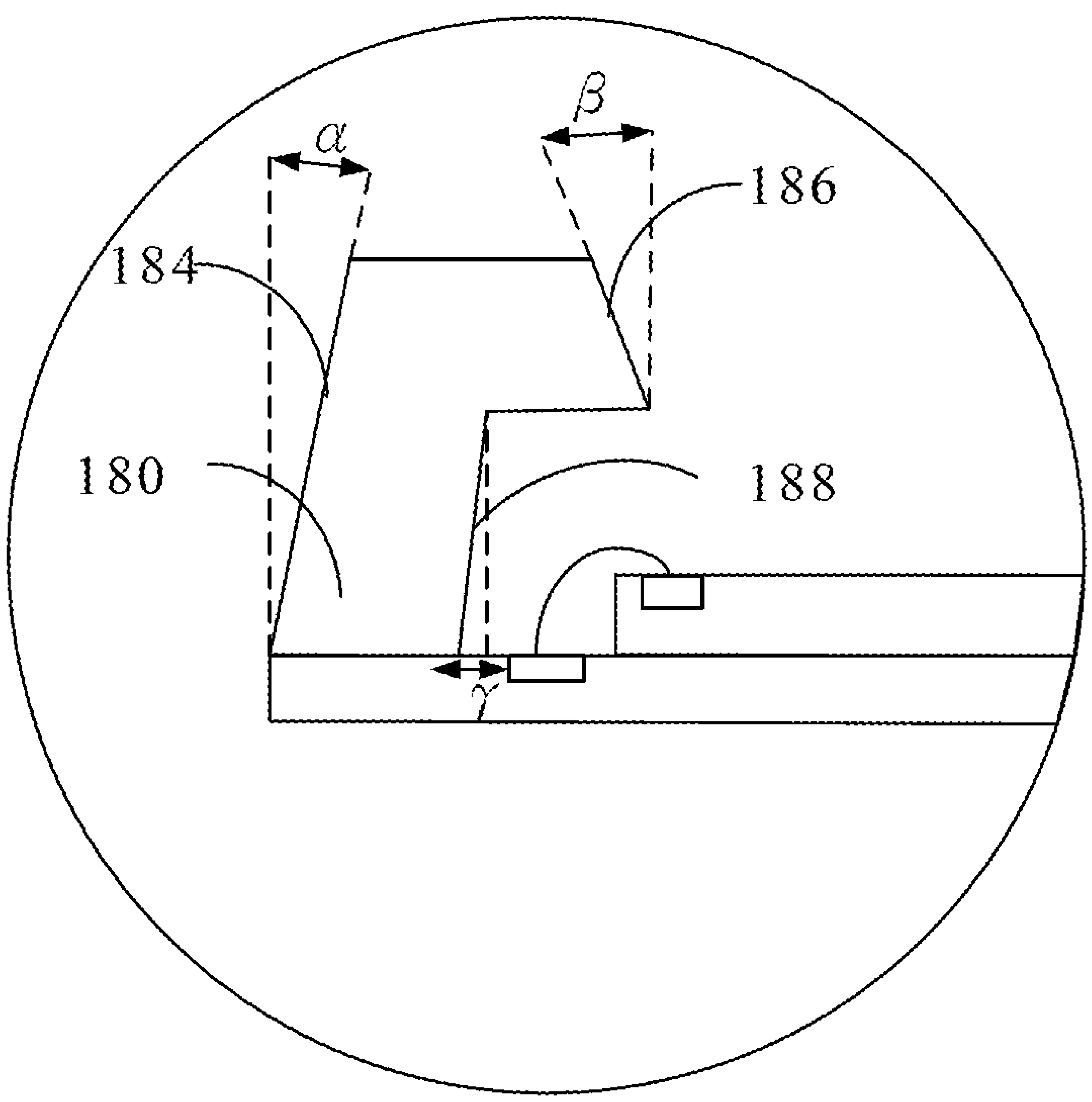


FIG. 14

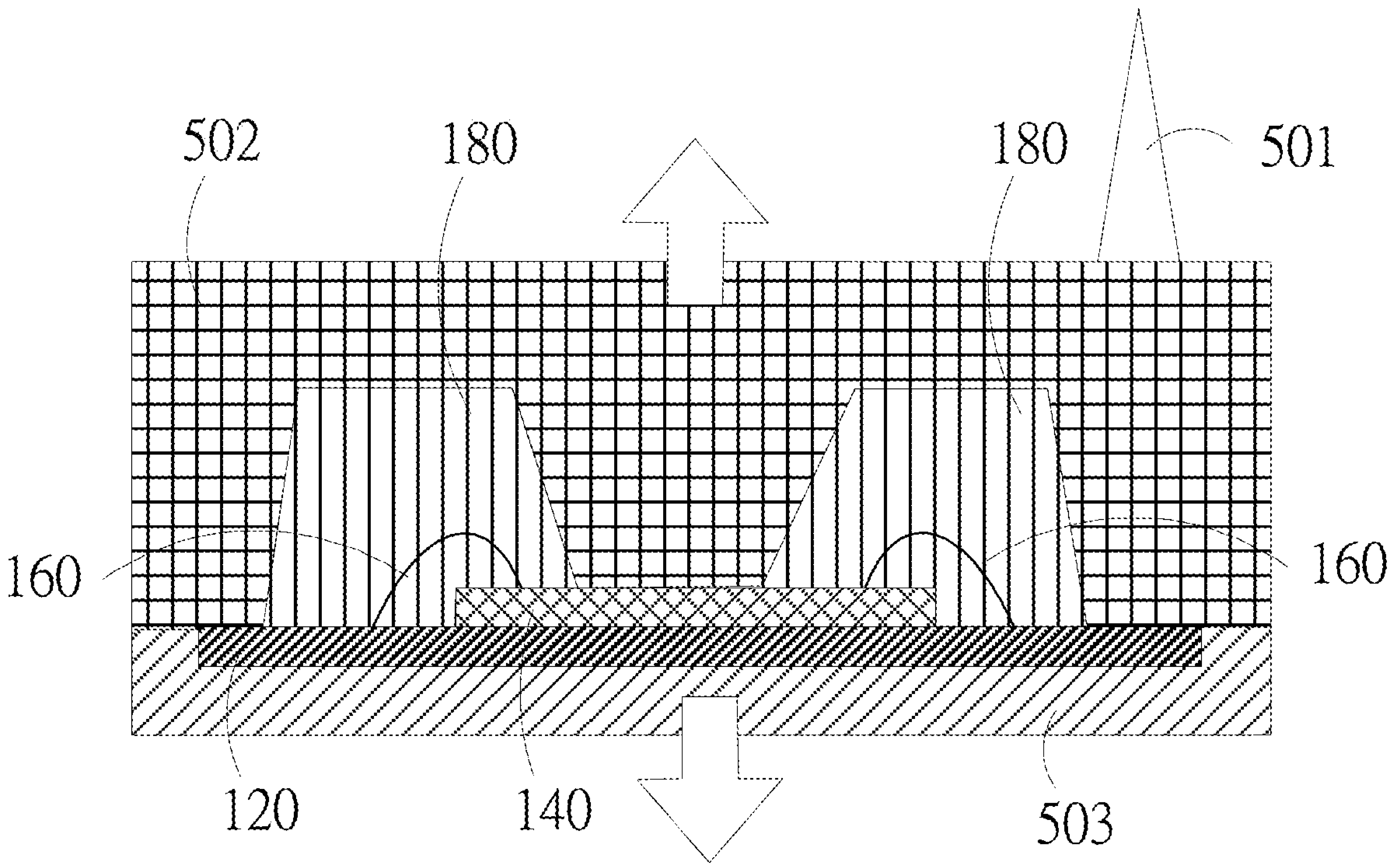


FIG. 15

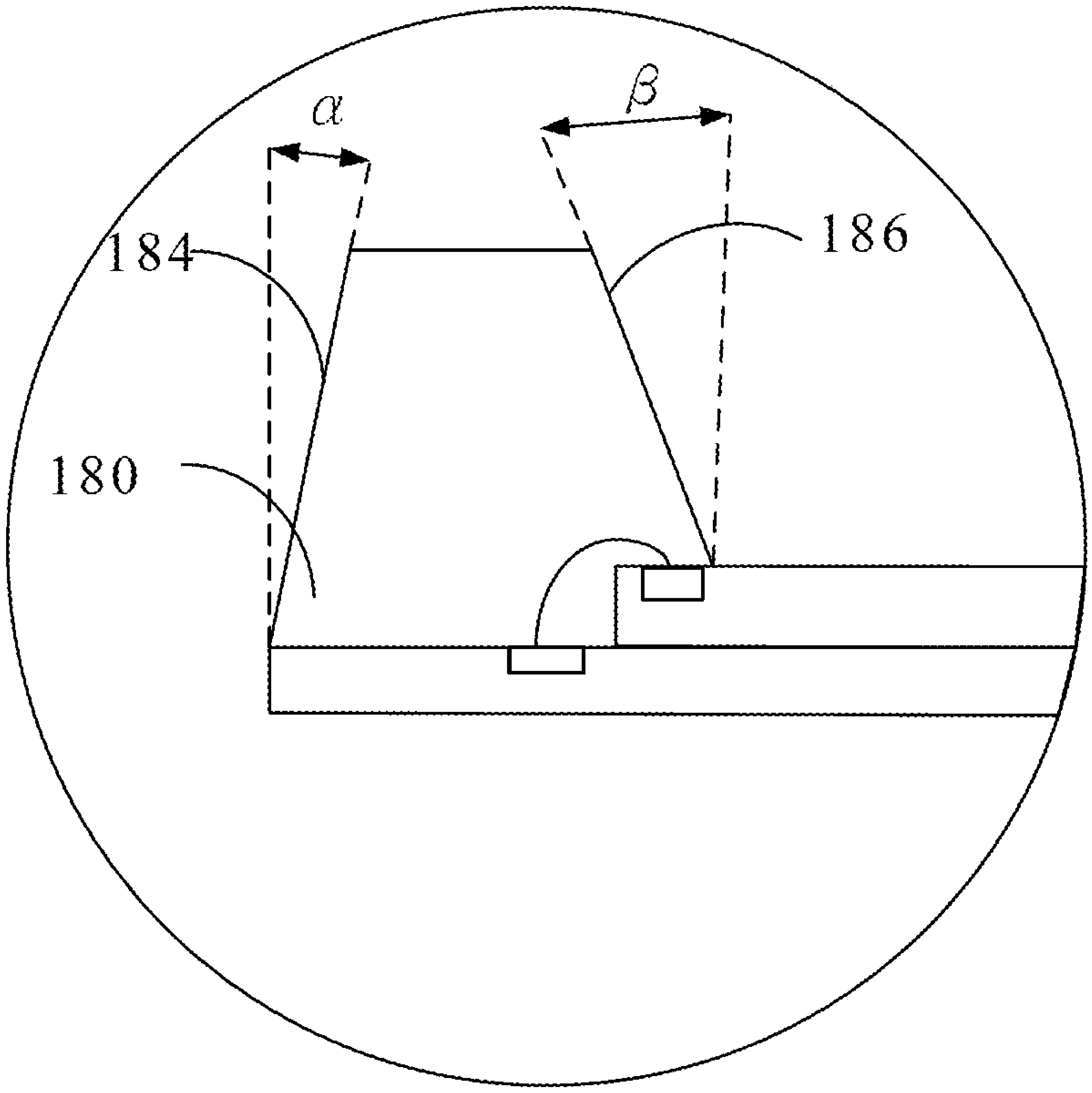


FIG. 16

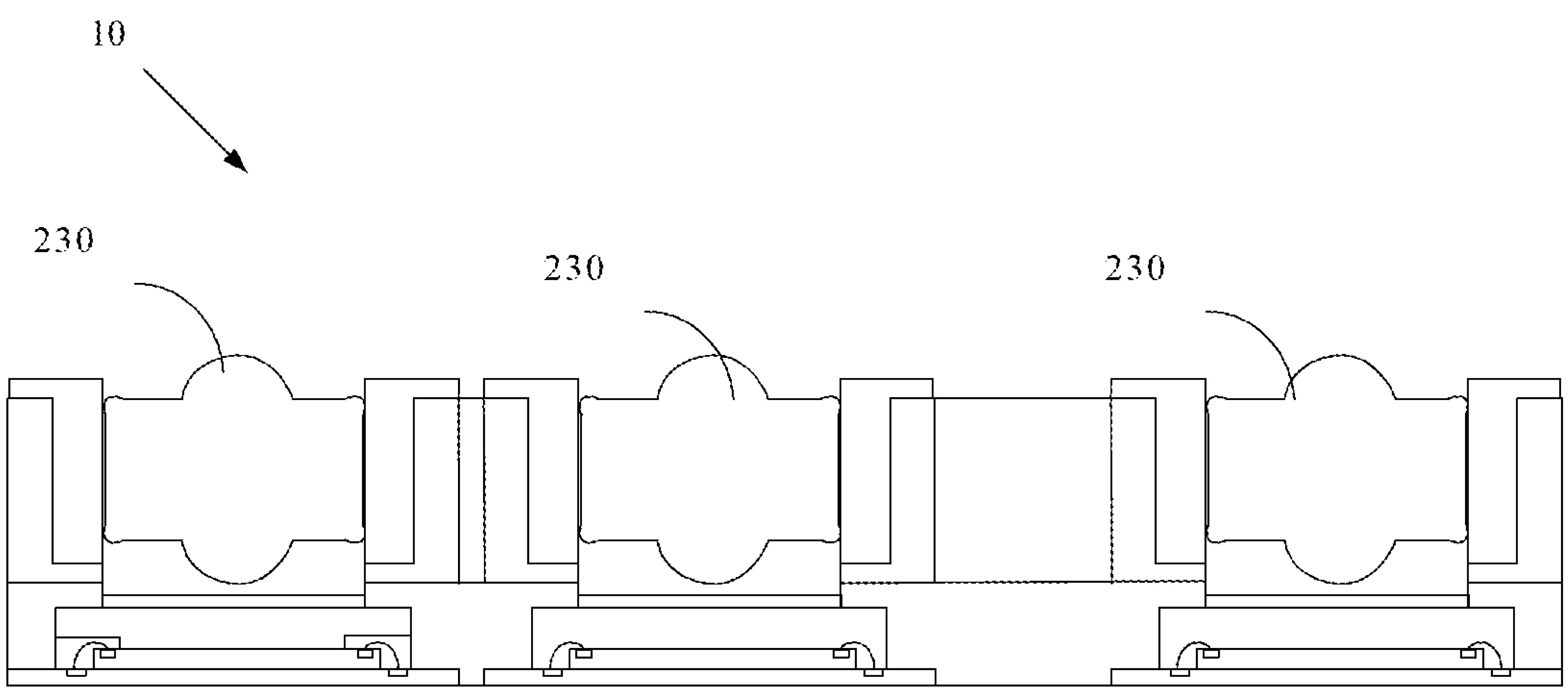
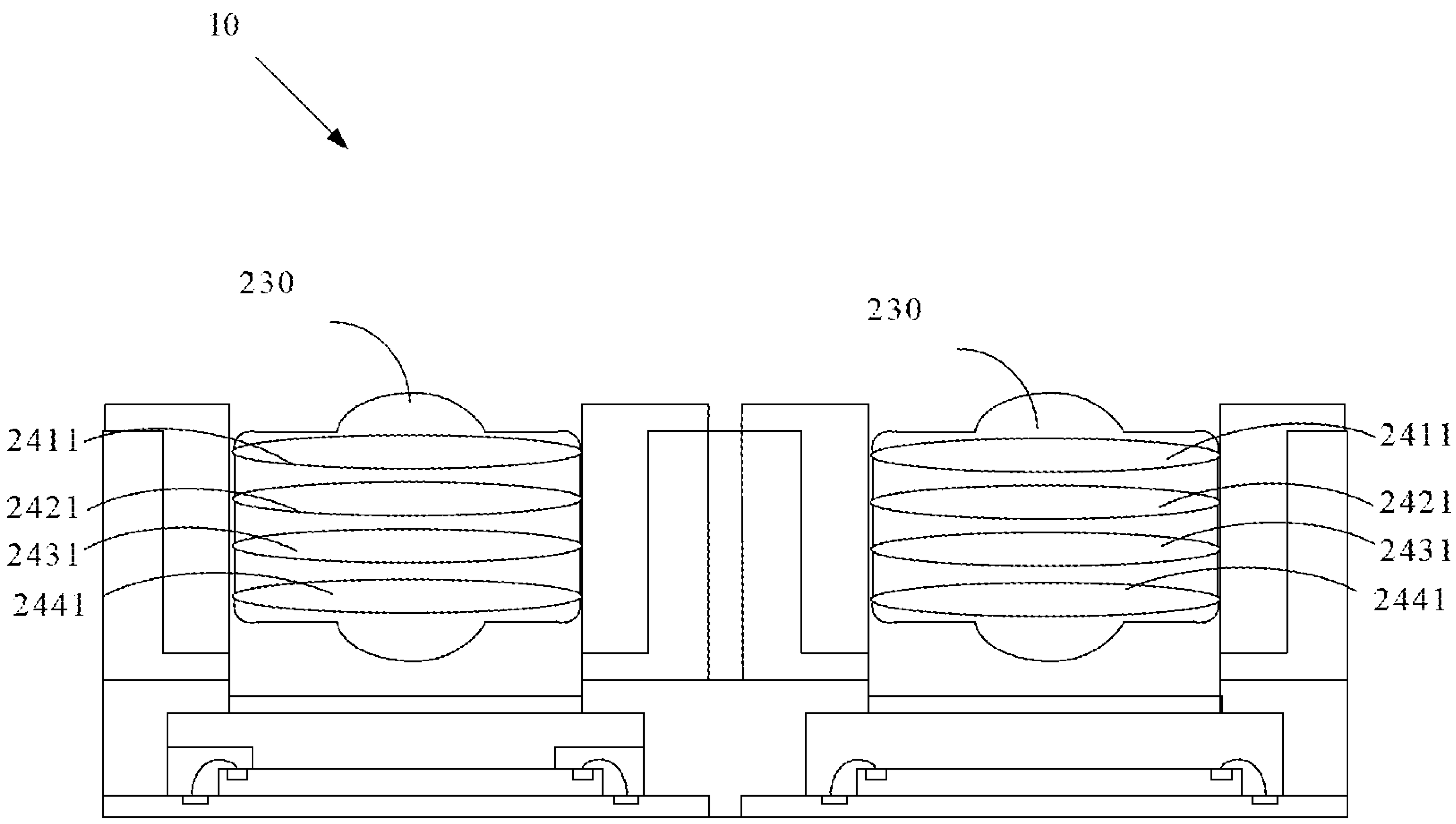


FIG. 17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2421
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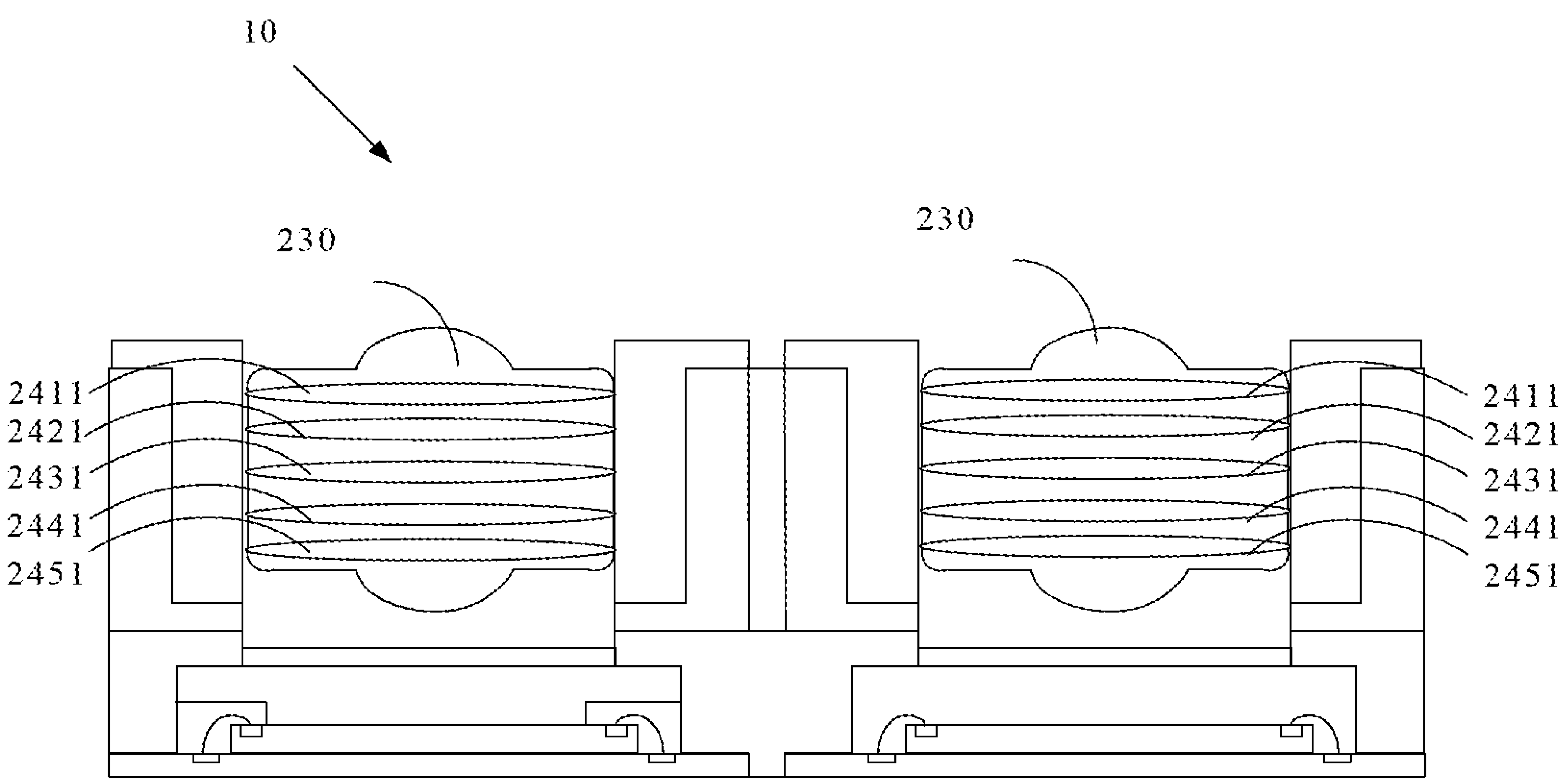
2431
2441

FIG. 18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2441
2451

FIG. 19

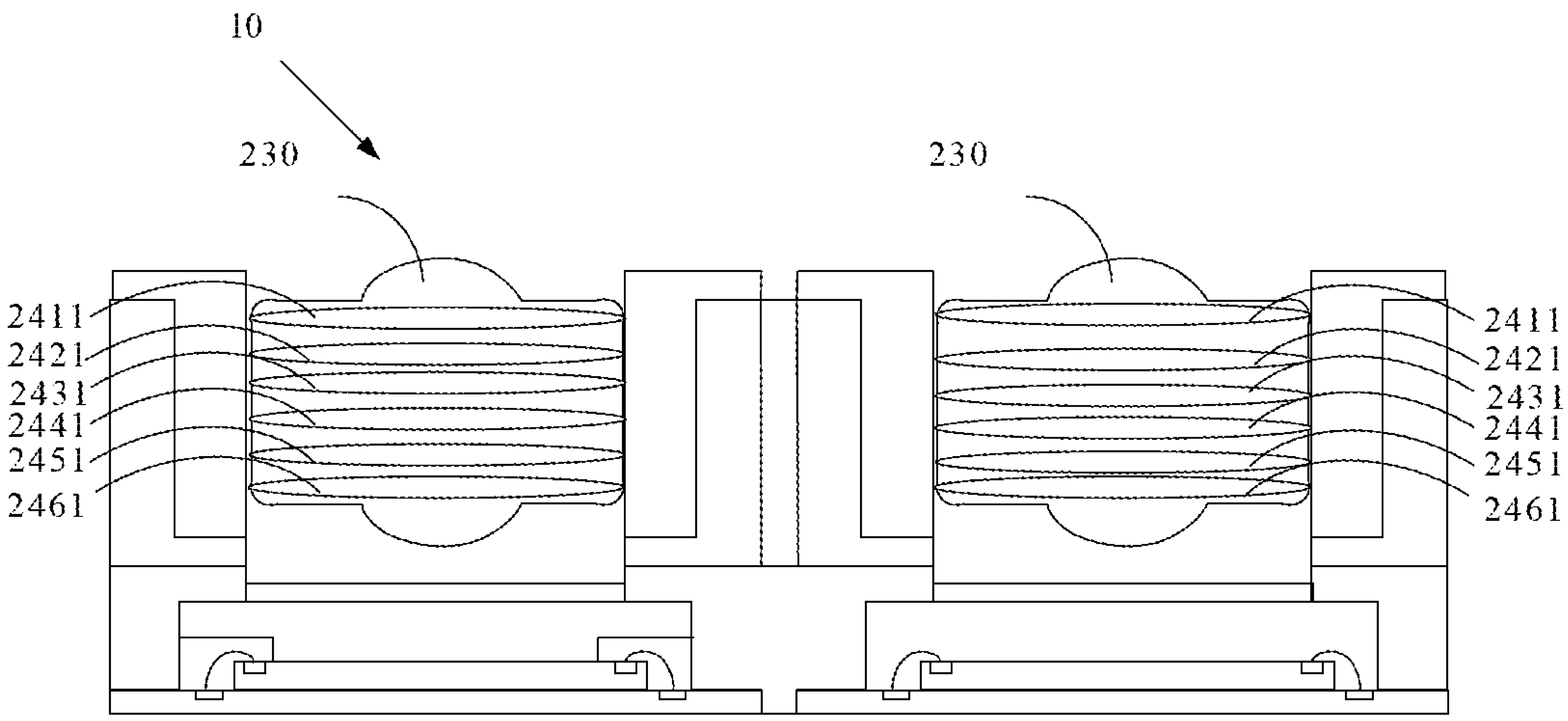
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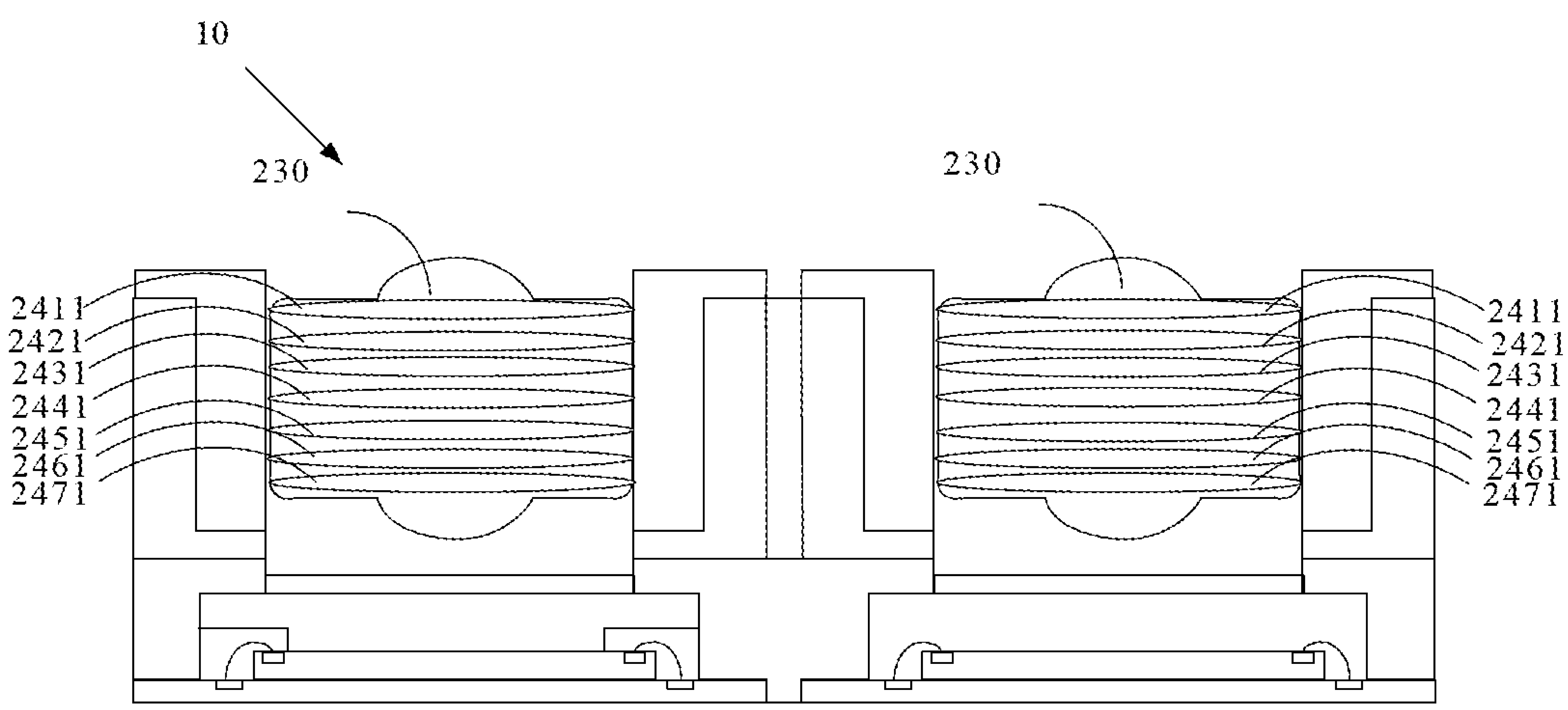
FIG. 20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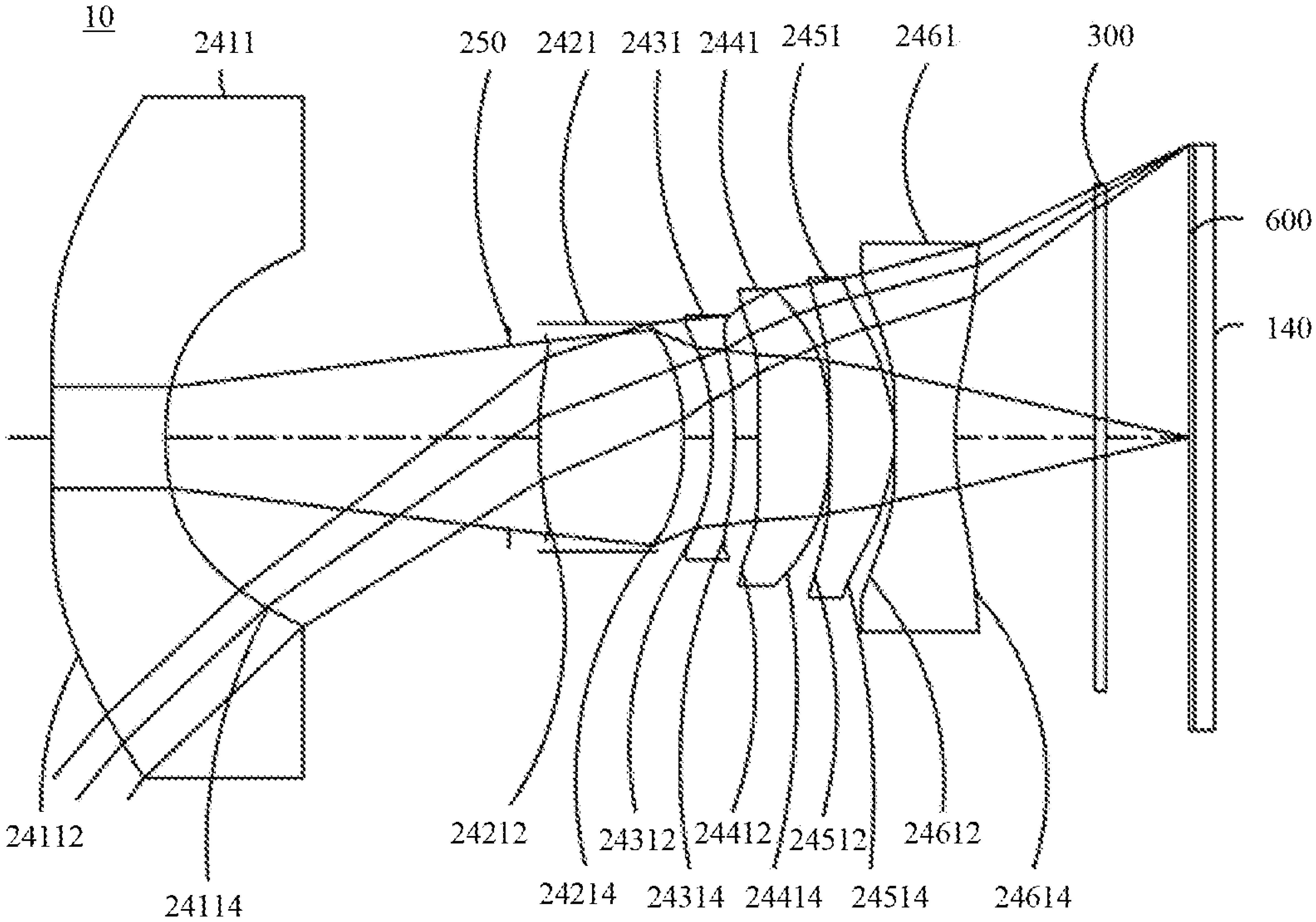
2461
2471

FIG. 21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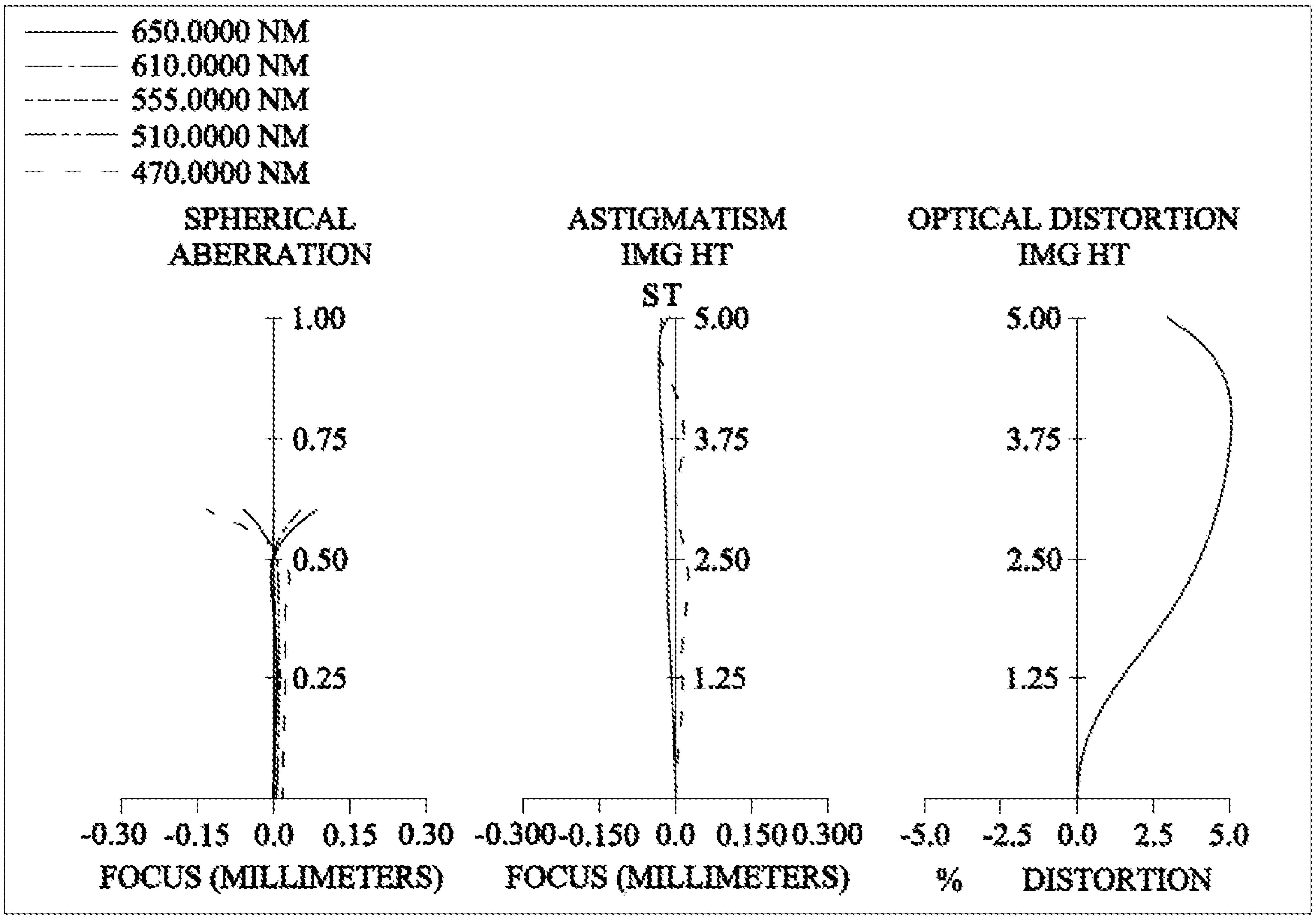
24514
24612
24614

FIG. 22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555.0000 NM
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ASTIGMATISM IMG HT
ST
OPTICAL DISTORTION IMG HT
1.00
0.75
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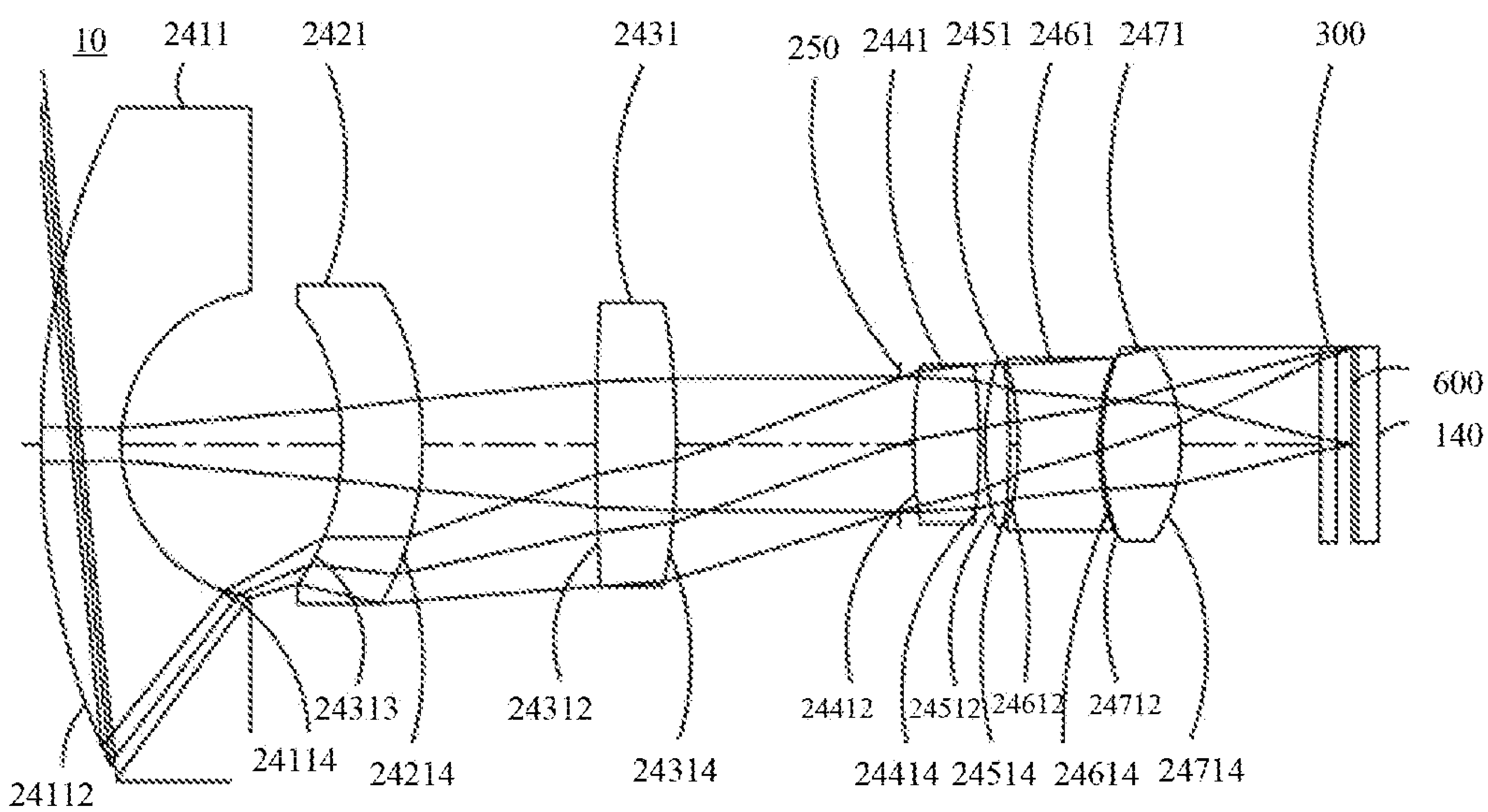
0.25
5.00
3.75
2.50
1.25
-0.30 -0.15 0.0 0.15 0.30
FOCUS (MILLIMETERS)
-0.300 -0.150 0.0 0.150 0.300
FOCUS (MILLIMETERS)
-5.0 -2.5 0.0 2.5 5.0
% DISTORTION

FIG. 23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24614
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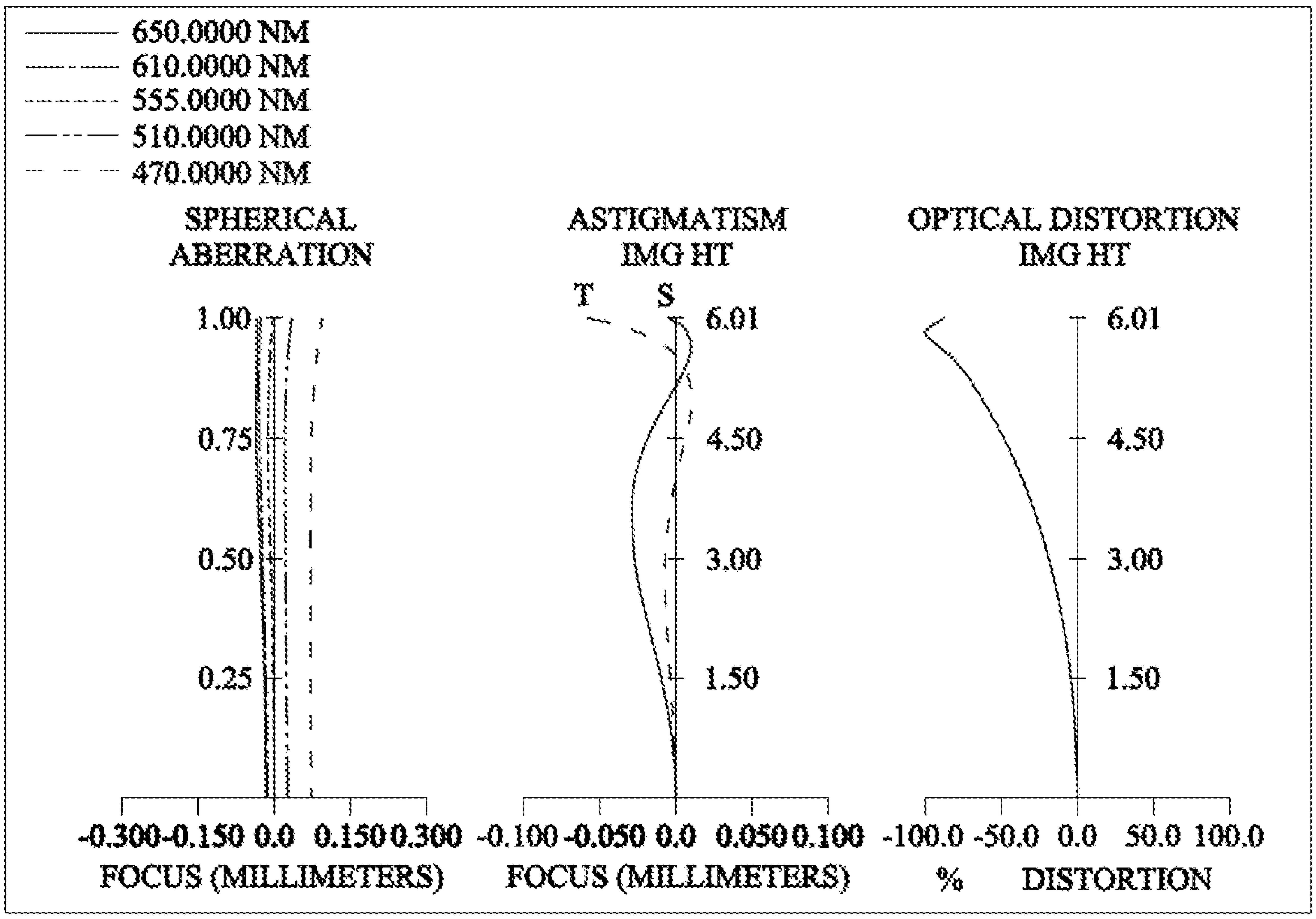
FIG. 24



650.0000 NM
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555.0000 NM
510.0000 NM
470.0000 NM
SPHERICAL ABERRATION
ASTIGMATISM IMG HT
OPTICAL DISTORTION IMG HT
T
S
1.00
0.75
0.50
0.25
6.01
4.50
3.00
1.50
-0.300 -0.150 0.0 0.150 0.300
FOCUS (MILLIMETERS)
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
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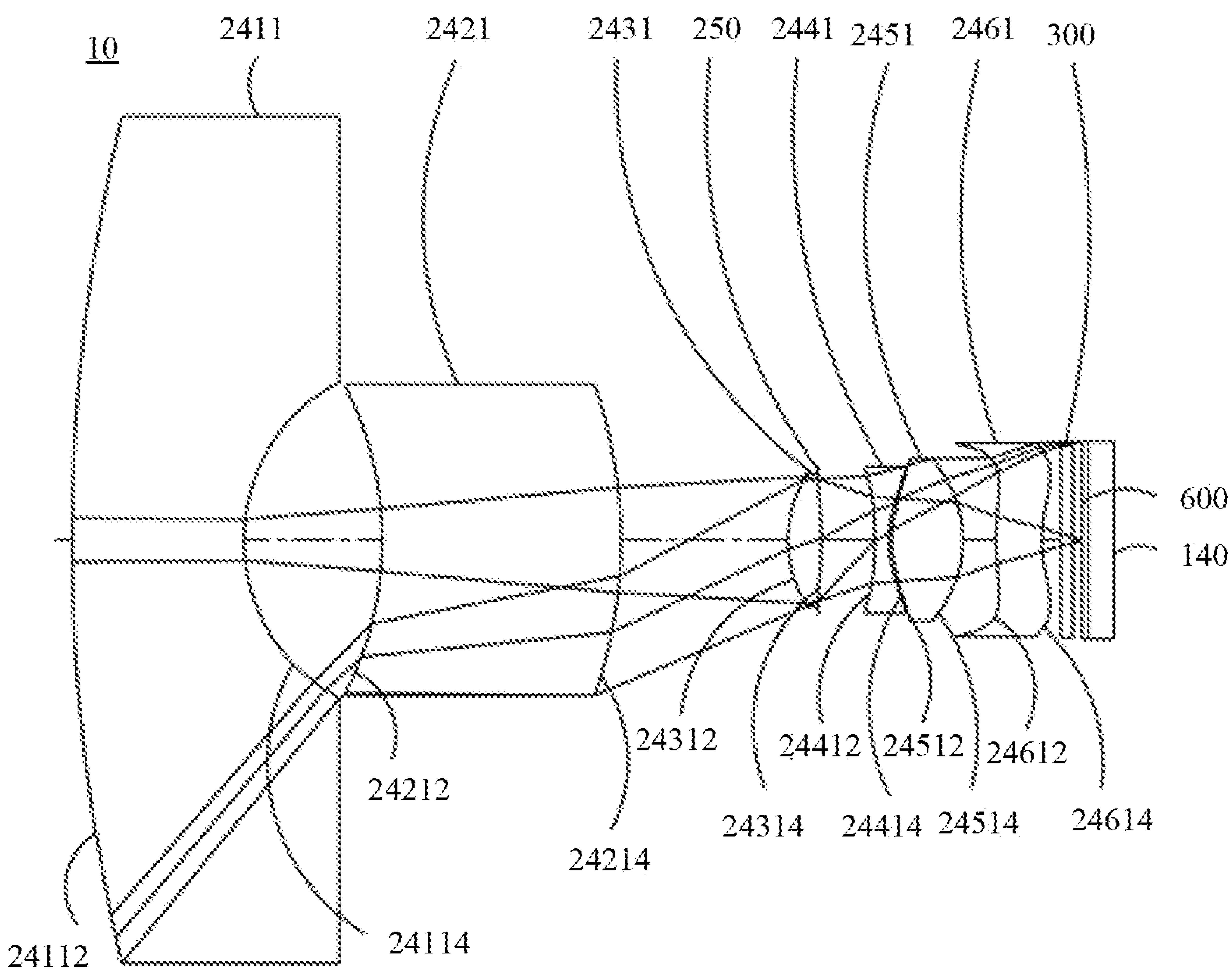
% DISTORTION

FIG. 25



10
2411
2421
2431
250
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2451
2461
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600
140
24312
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24414
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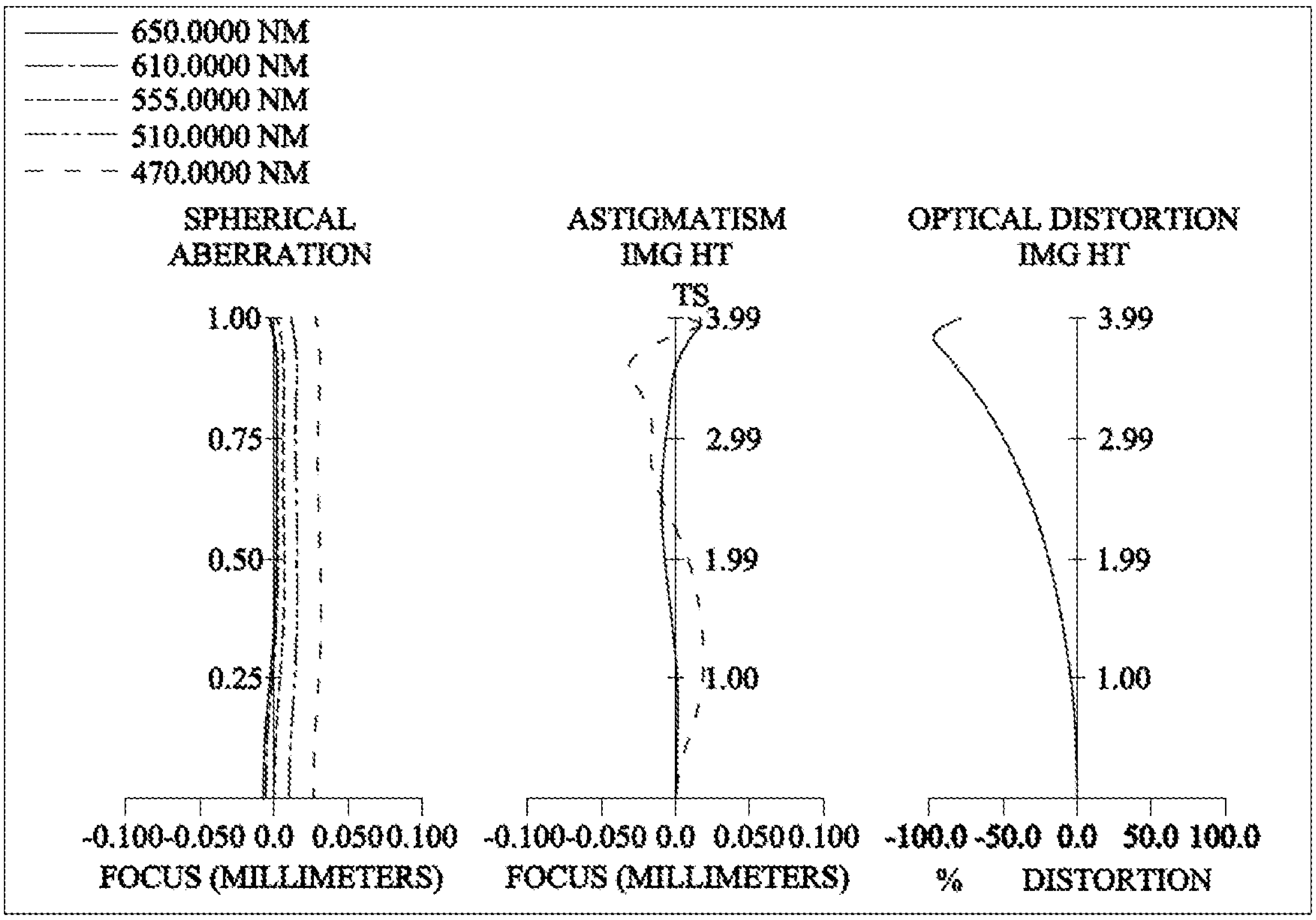
24614
24214
24112
24114

FIG. 26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555.0000 NM
510.0000 NM
470.0000 NM
SPHERICAL
ABERRATION
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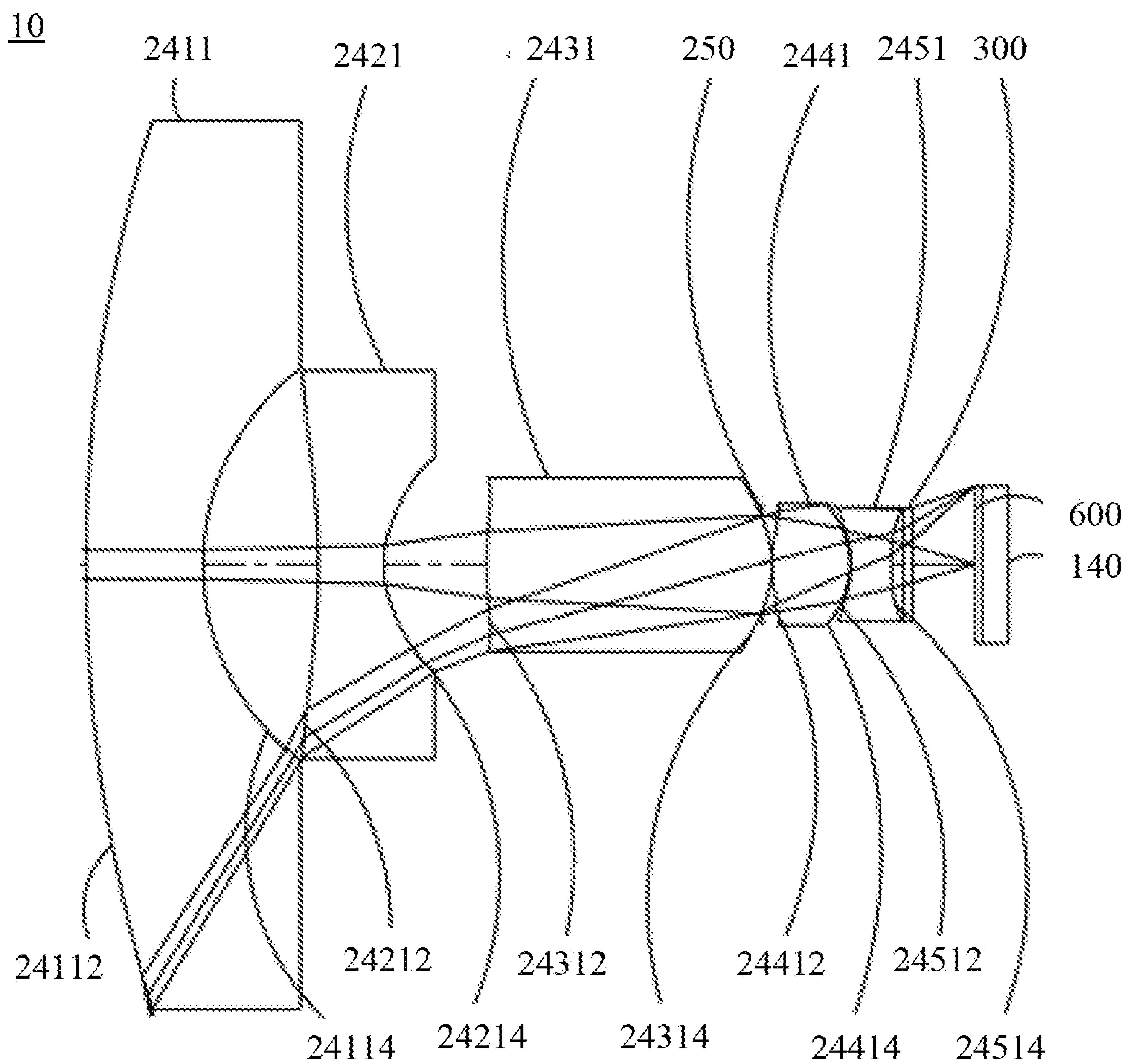
0.50
0.25
-0.100-0.050 0.0 0.0500.100
FOCUS (MILLIMETERS)
ASTIGMATISM
IMG HT
TS
3.99
2.99
1.99
1.00
-0.100-0.050 0.0 0.0500.100
FOCUS (MILLIMETERS)
OPTICAL DISTORTION
IMG HT
3.99
2.99
1.99
1.00
-100.0 -50.0 0.0 50.0 100.0
% DISTORTION

FIG. 27


10
2411
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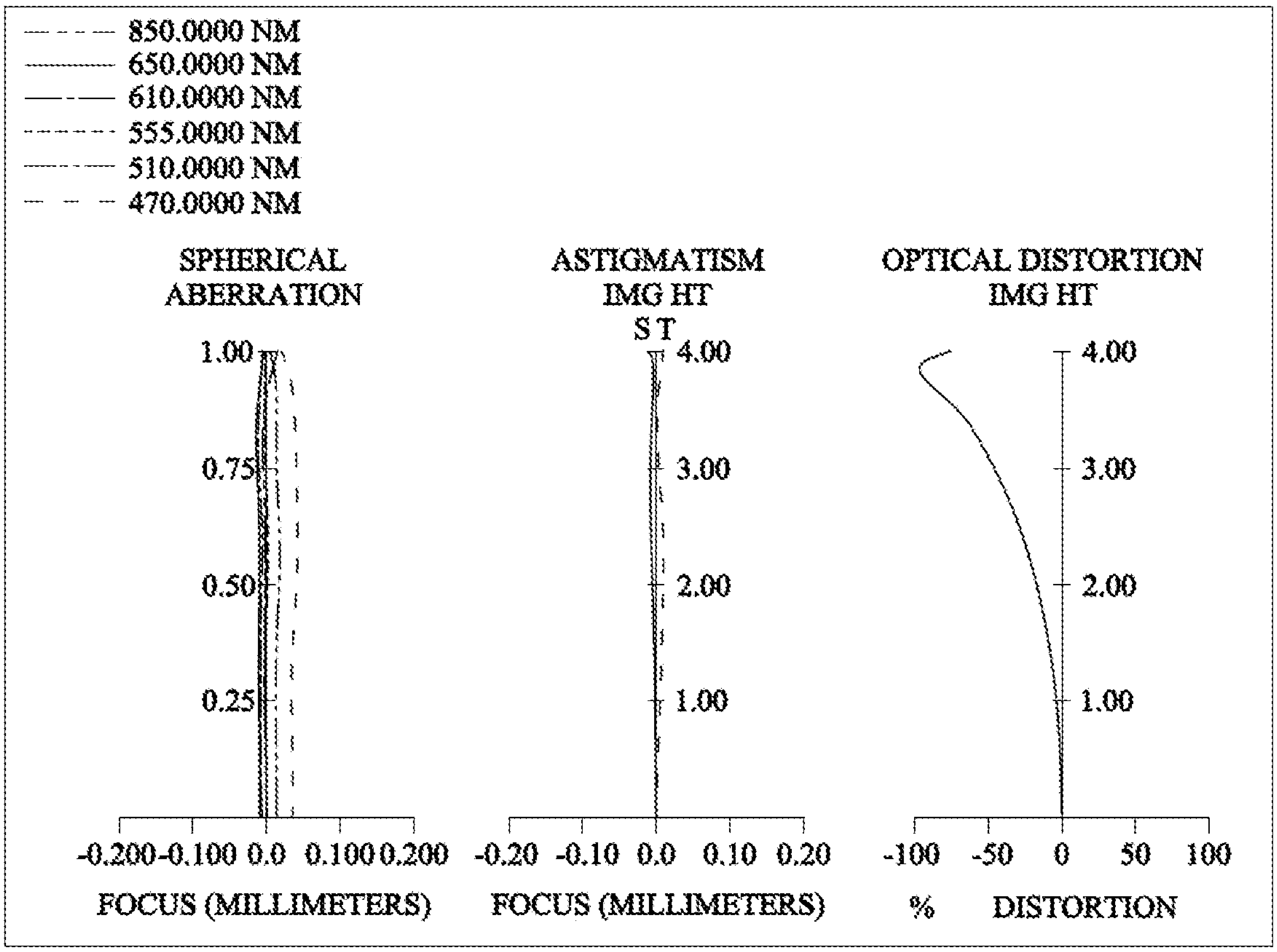
24514

FIG. 28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555.0000 NM
510.0000 NM
470.0000 NM
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0.50
0.25
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ASTIGMATISM IMG HT
S T
4.00
3.00
2.00
1.00
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FOCUS (MILLIMETERS)
OPTICAL DISTORTION IMG HT
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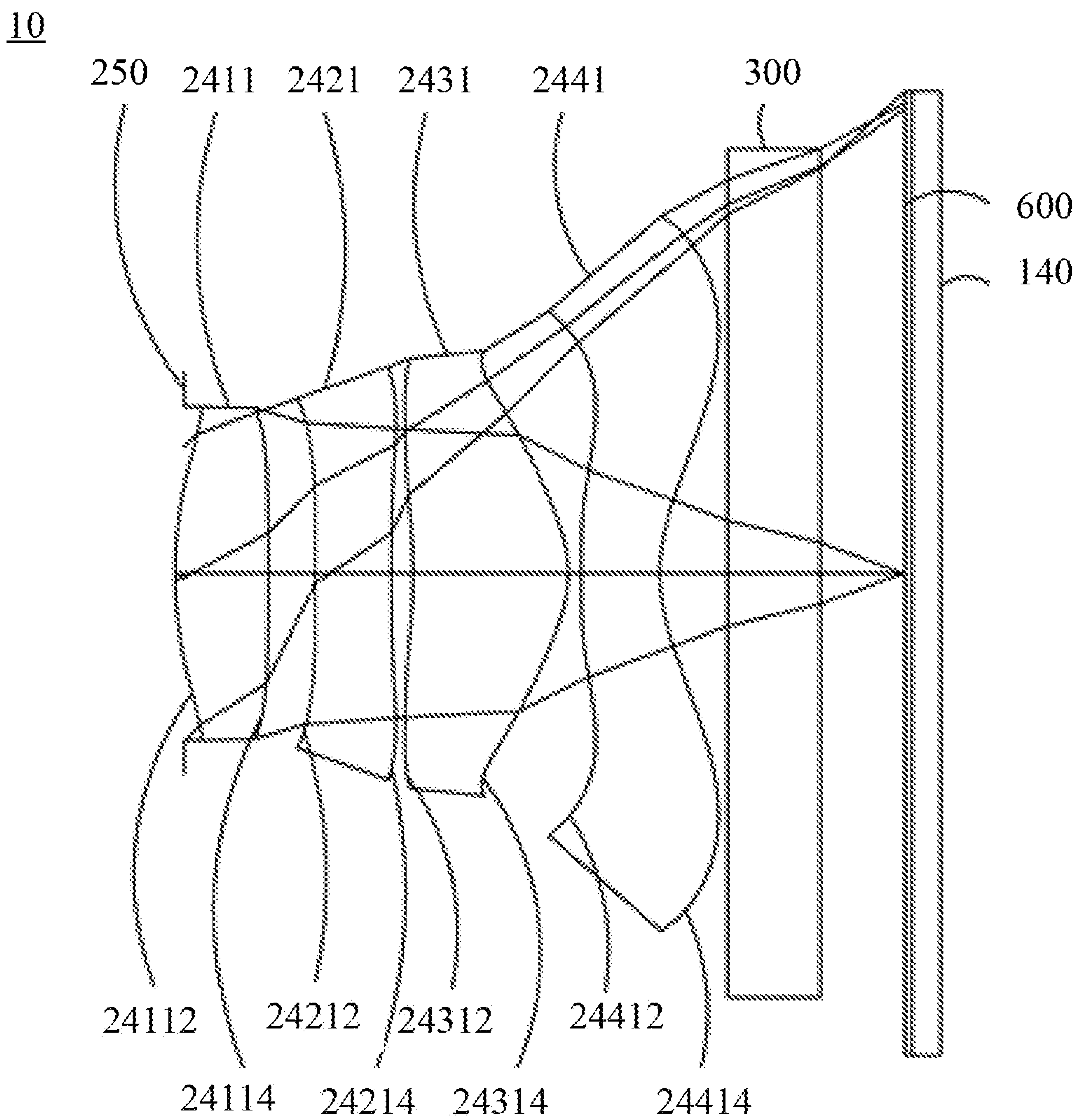
3.00
2.00
1.00
-100 -50 0 50 100
% DISTORTION

FIG. 29


10
250
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140
24112
24212
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24114
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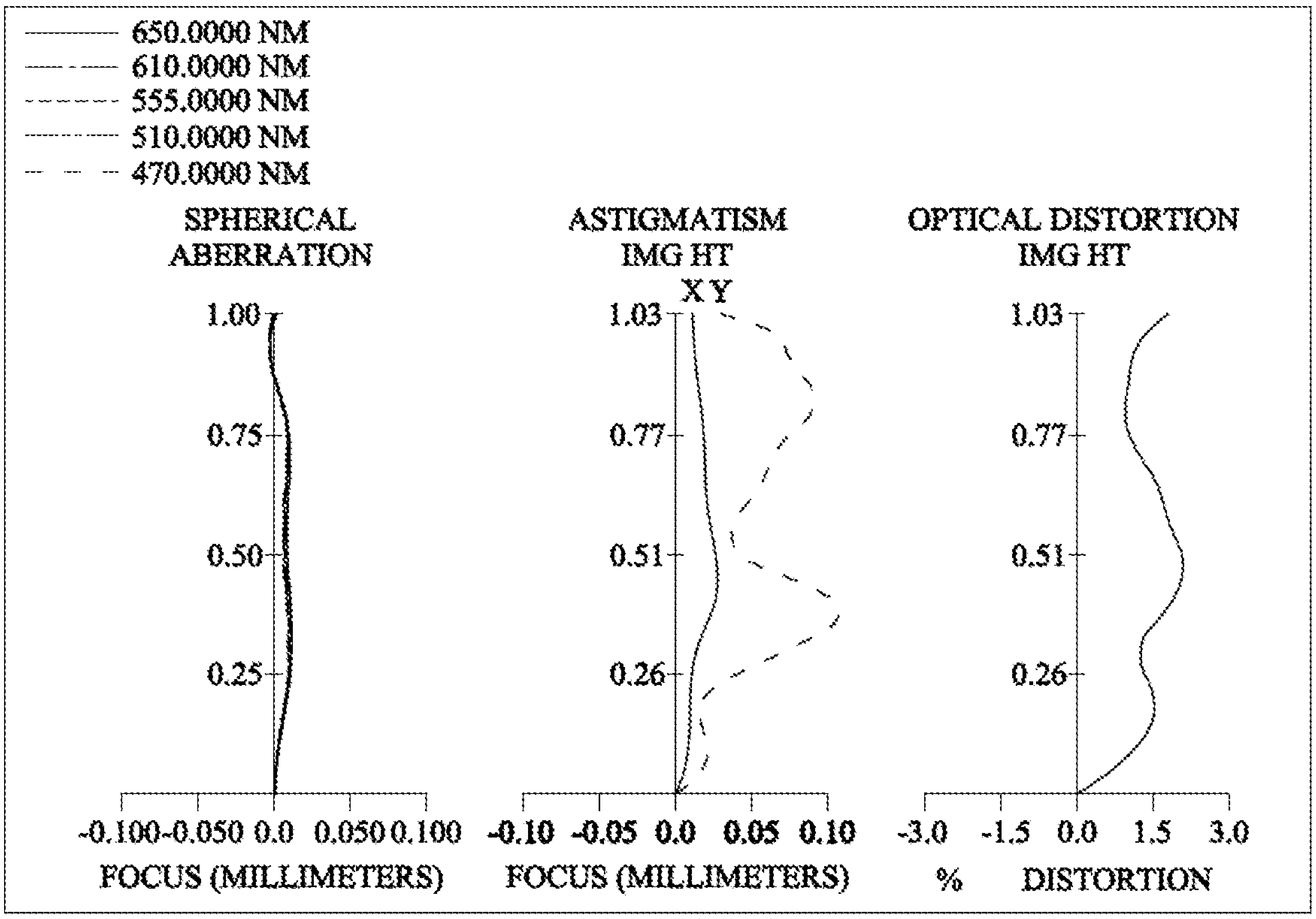
24314
24414

FIG. 30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555.0000 NM
510.0000 NM
470.0000 NM
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1.00
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0.50
0.25
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
ASTIGMATISM IMG HT
X Y
1.03
0.77
0.51
0.26
-0.10 -0.05 0.0 0.05 0.10
FOCUS (MILLIMETERS)
OPTICAL DISTORTION IMG HT
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0.26
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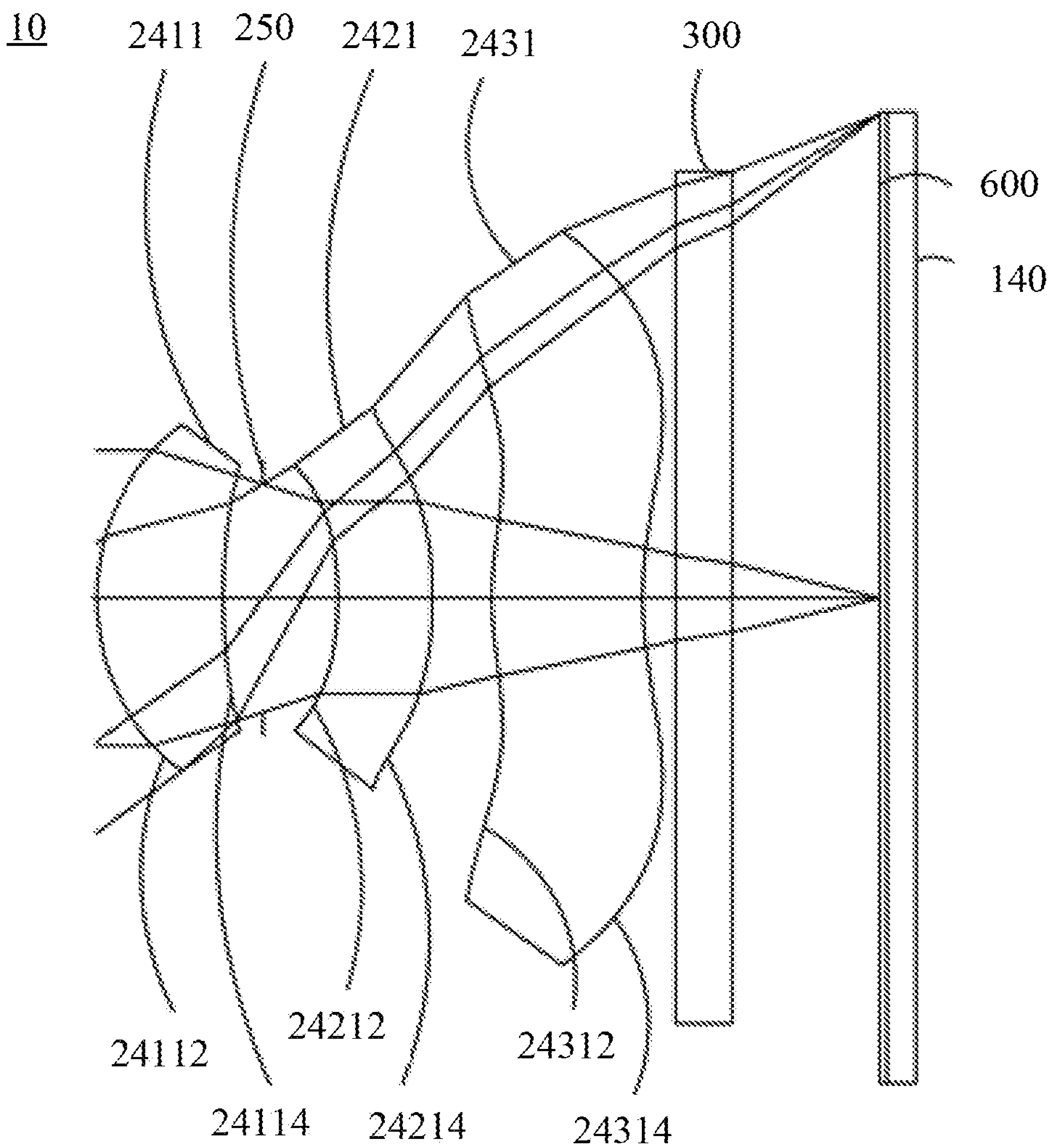
% DISTORTION

FIG. 31


10
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600
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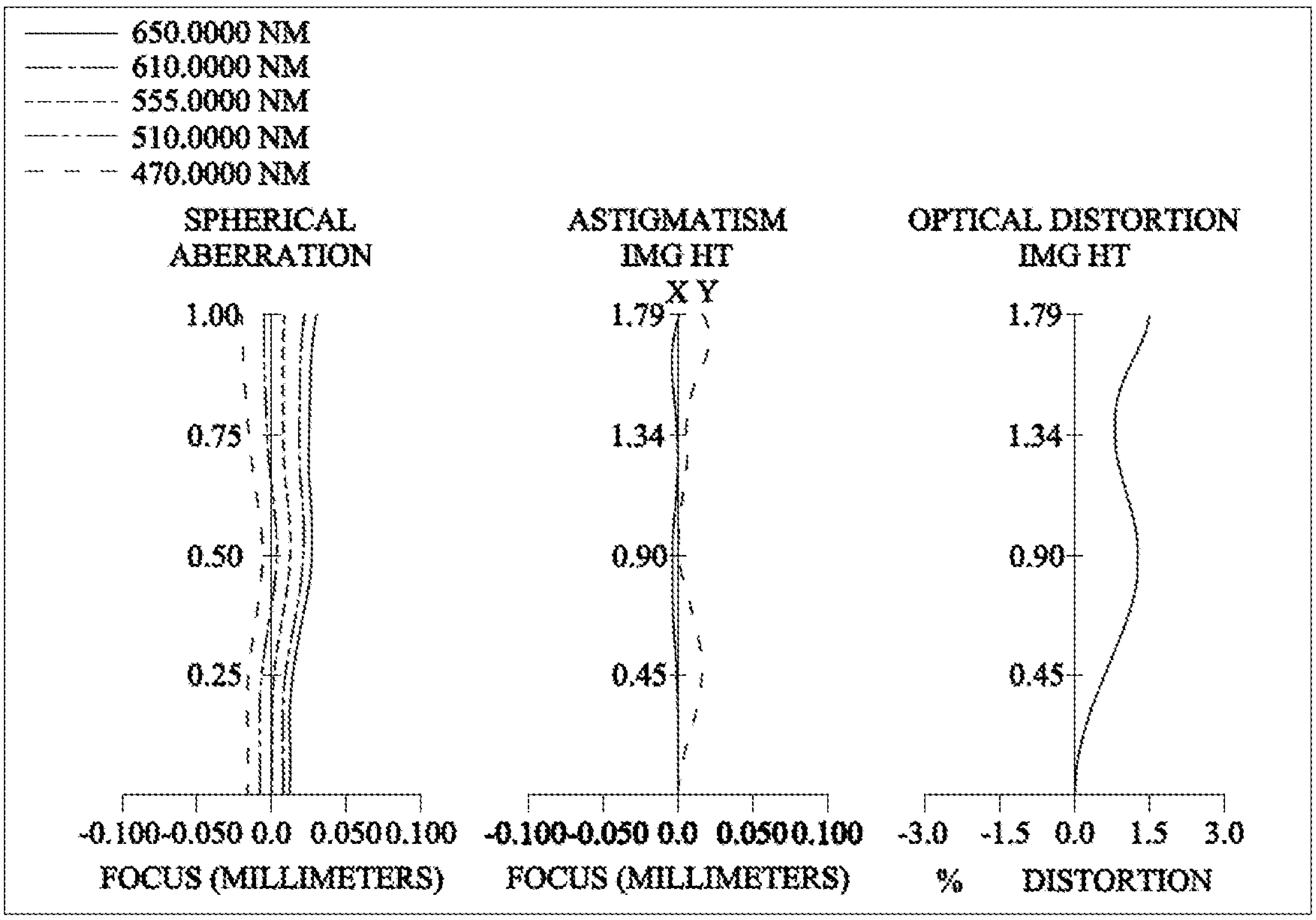
24112
24114
24212
24214
24312
24314

FIG. 32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X Y
OPTICAL DISTORTION IMG HT
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0.50
0.25
1.79
1.34
0.90
0.45
1.79
1.34
0.90
0.45
-0.100 -0.050 0.0 0.050 0.100
FOCUS (MILLIMETERS)
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FOCUS (MILLIMETERS)
-3.0 -1.5 0.0 1.5 3.0
% DISTORTION

FIG. 33

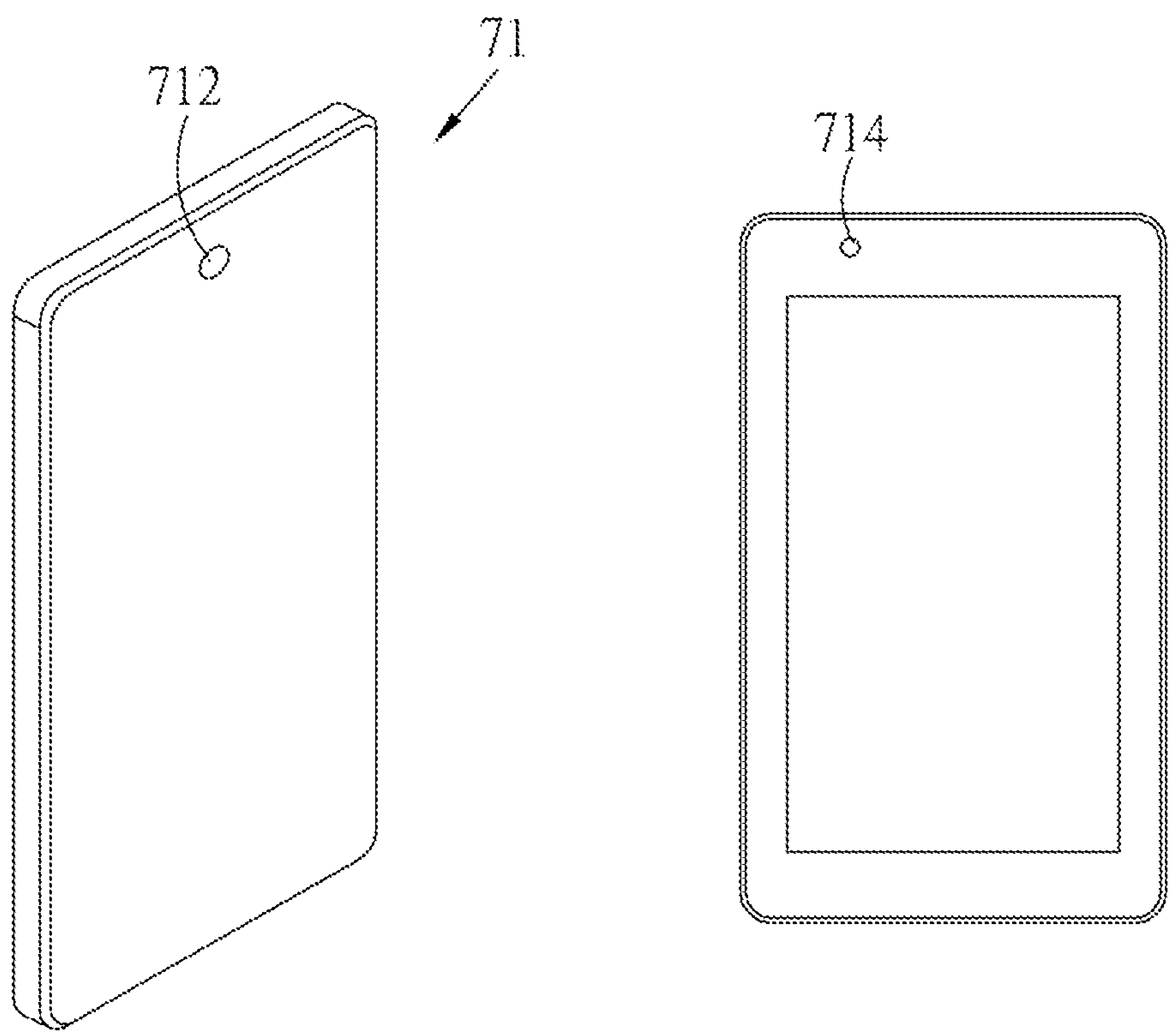

FIG. 34

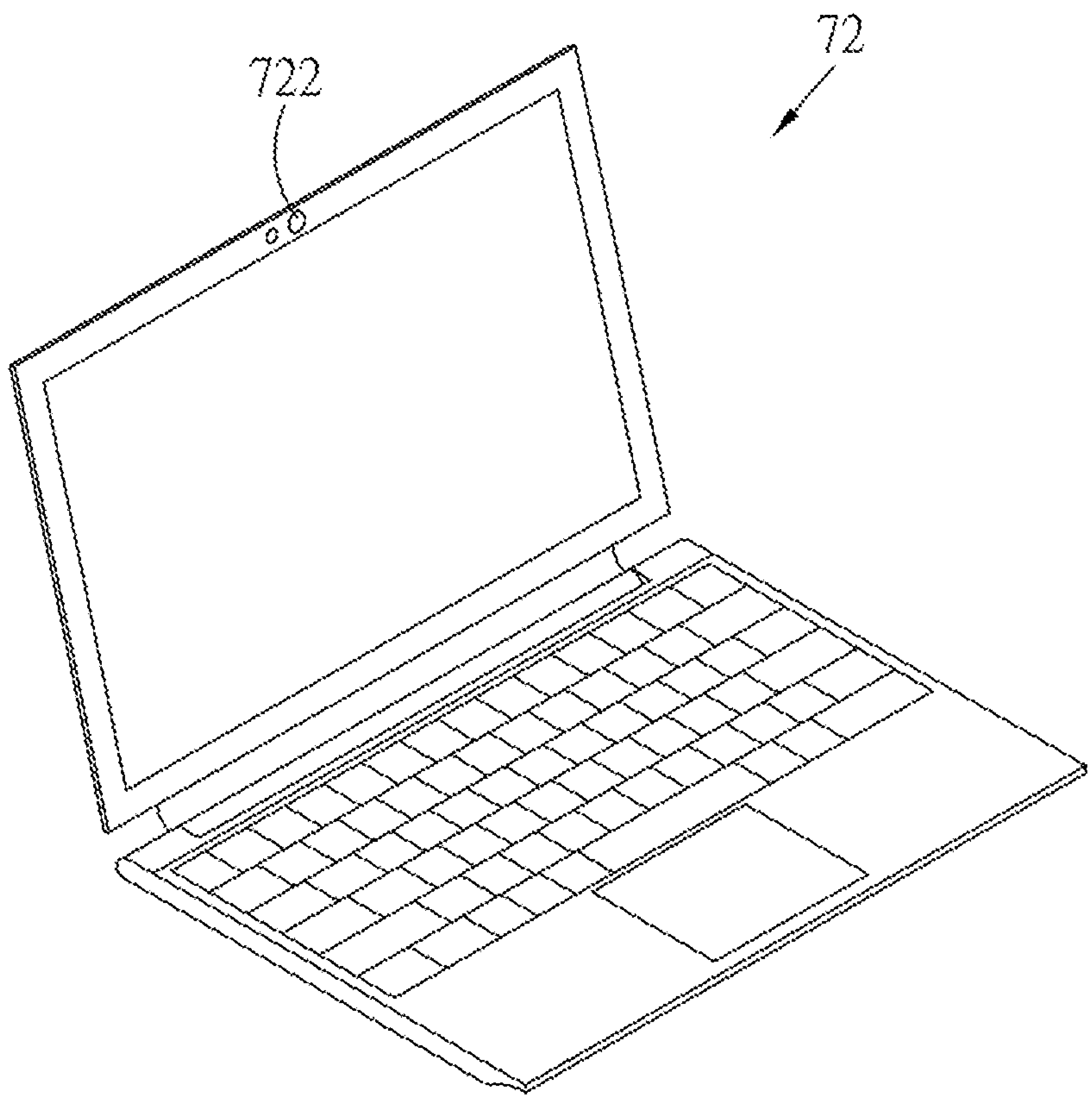

FIG. 35

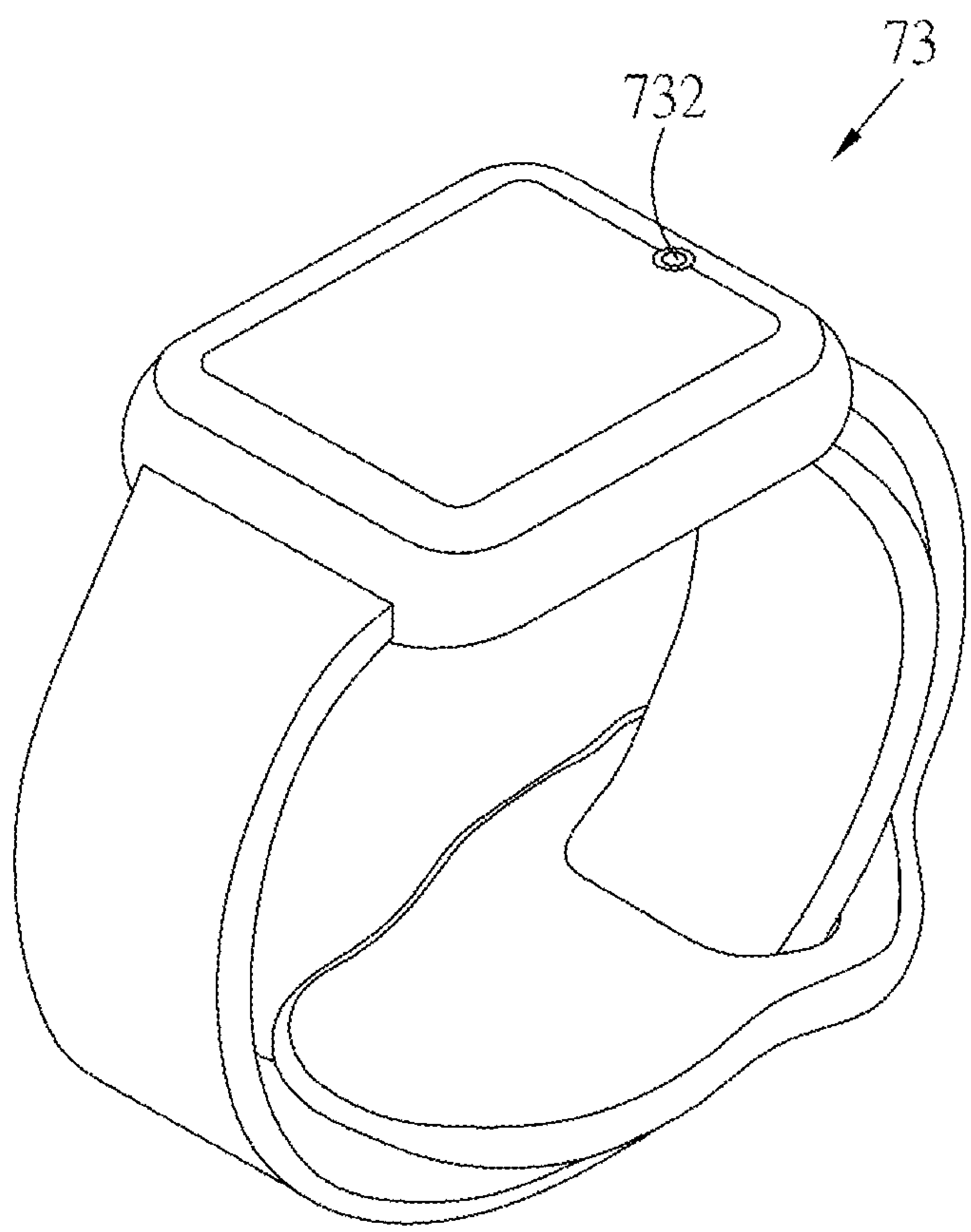

FIG. 36

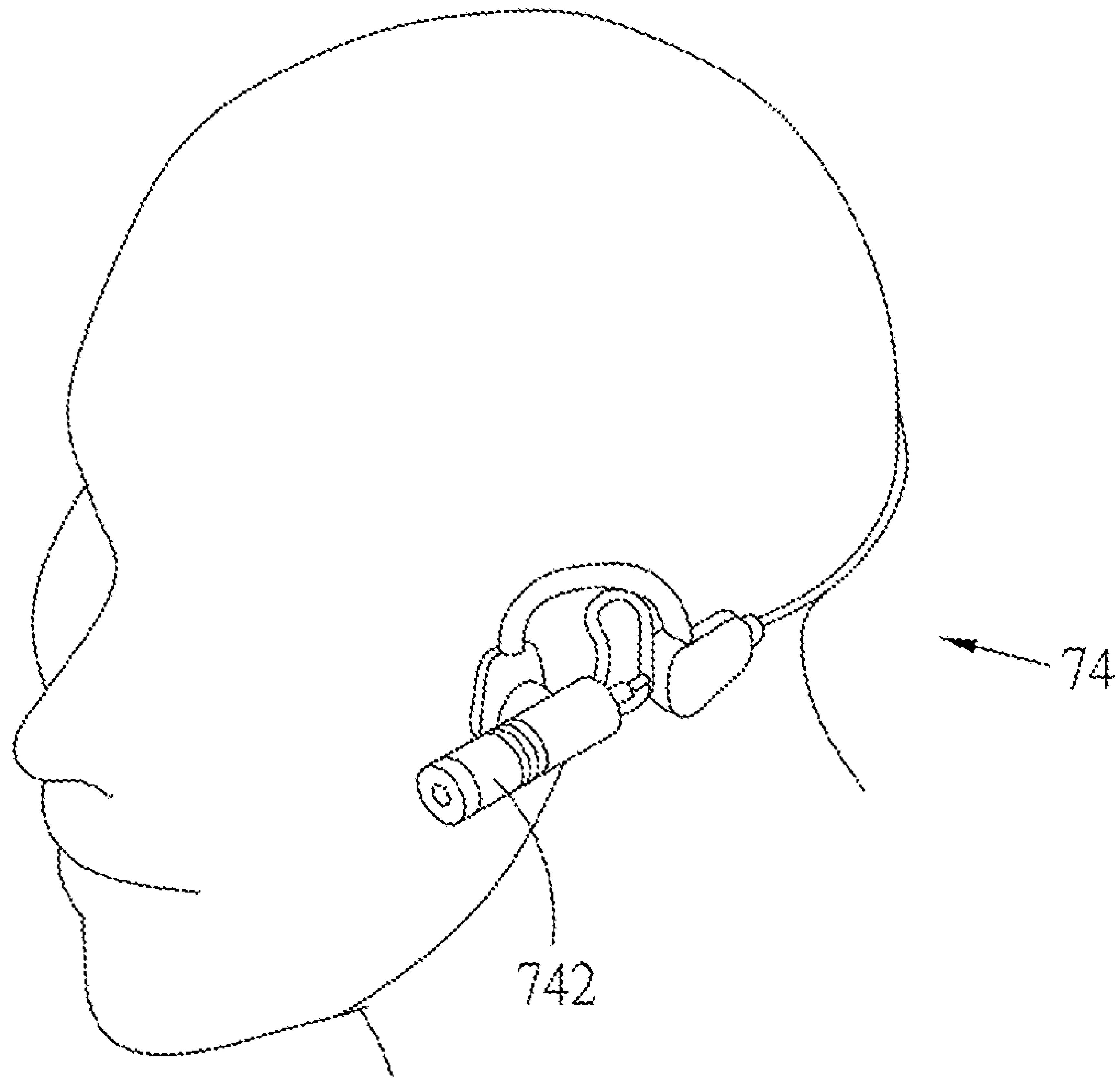

FIG. 37

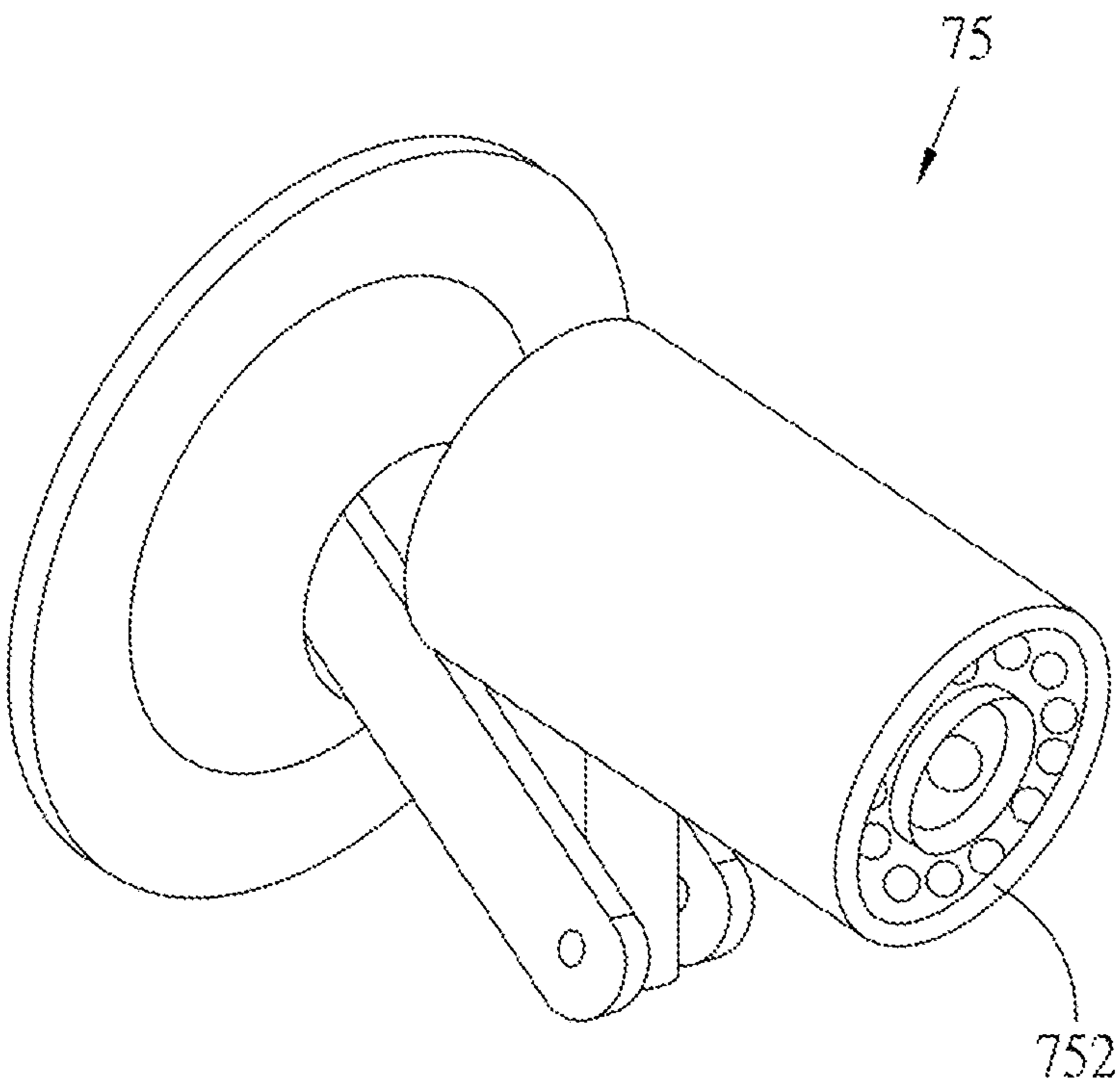

FIG. 38

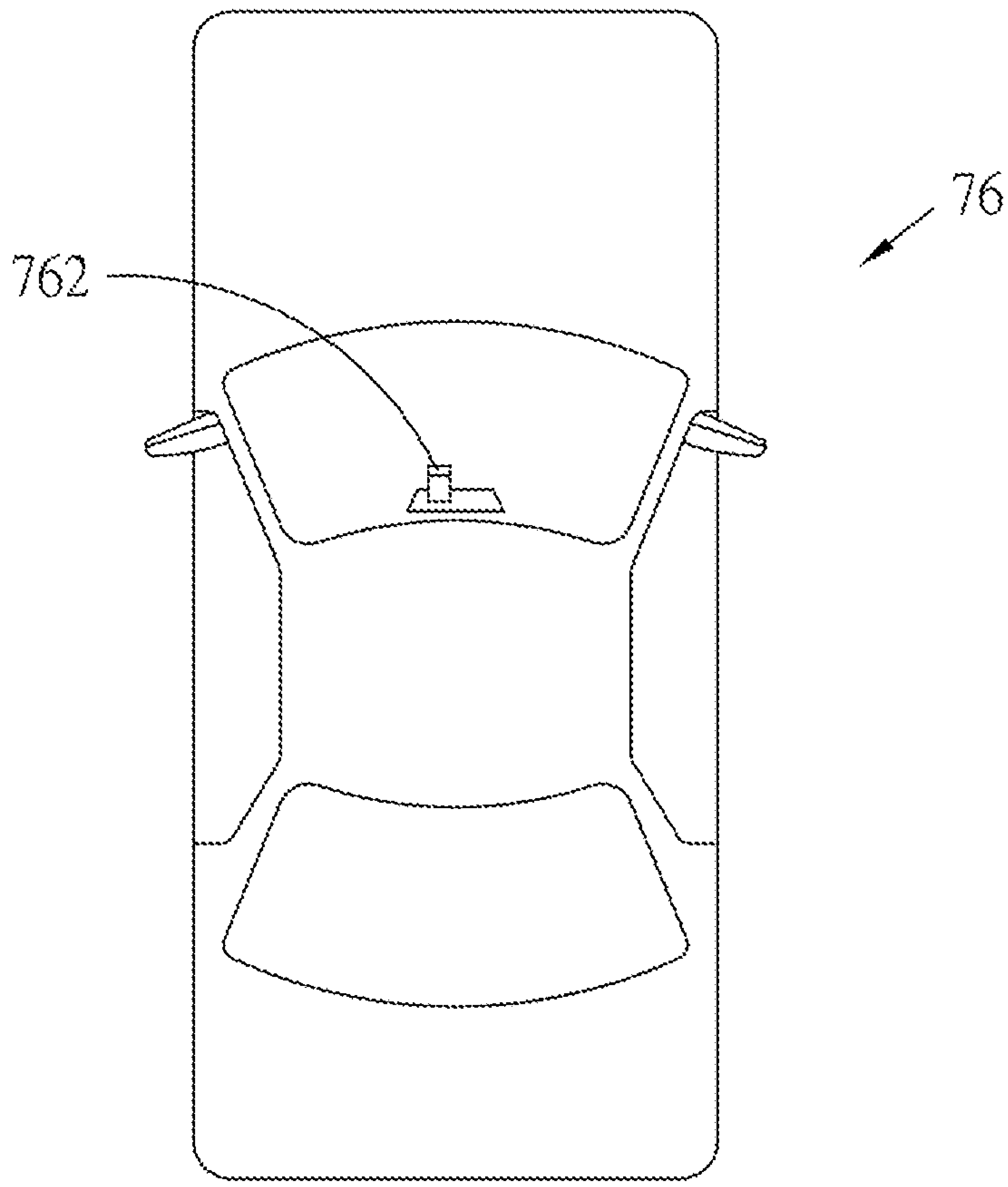

FIG. 39

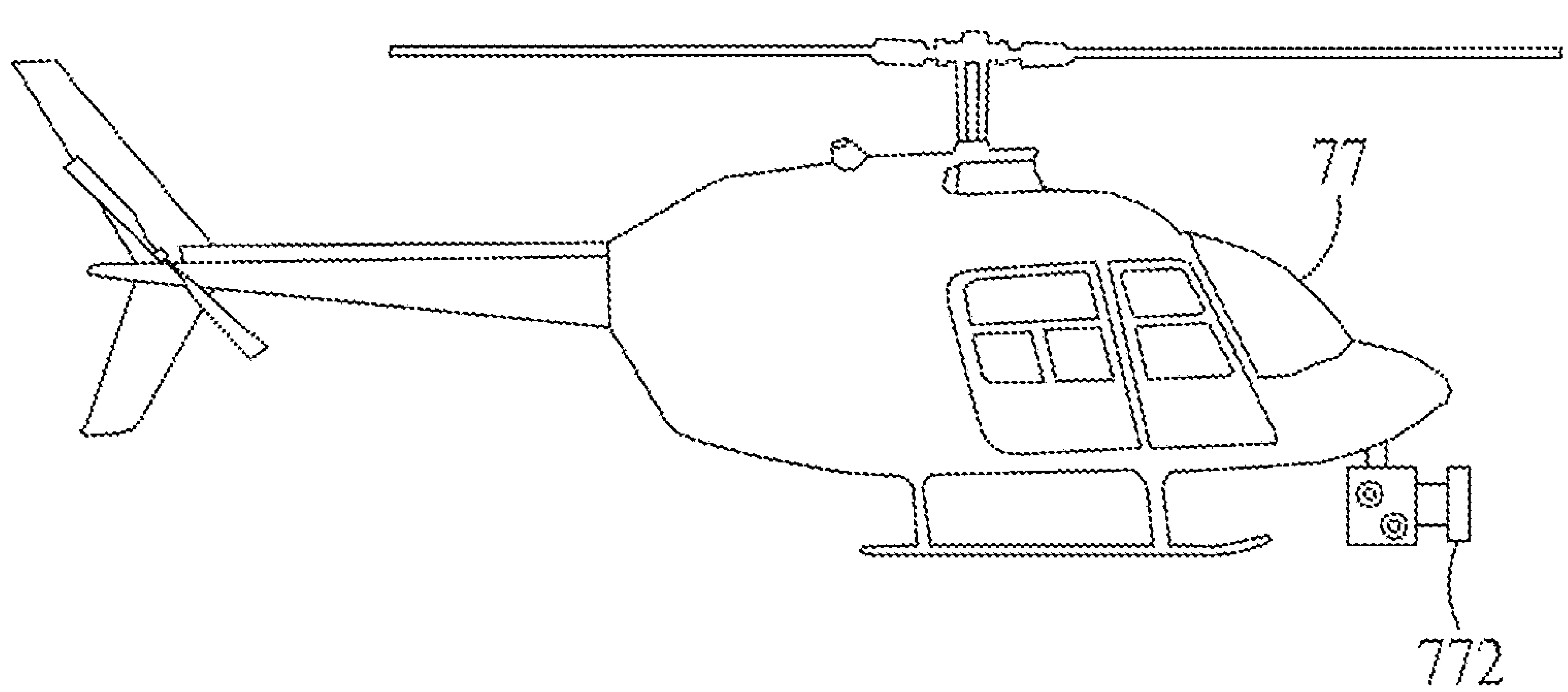

FIG. 40

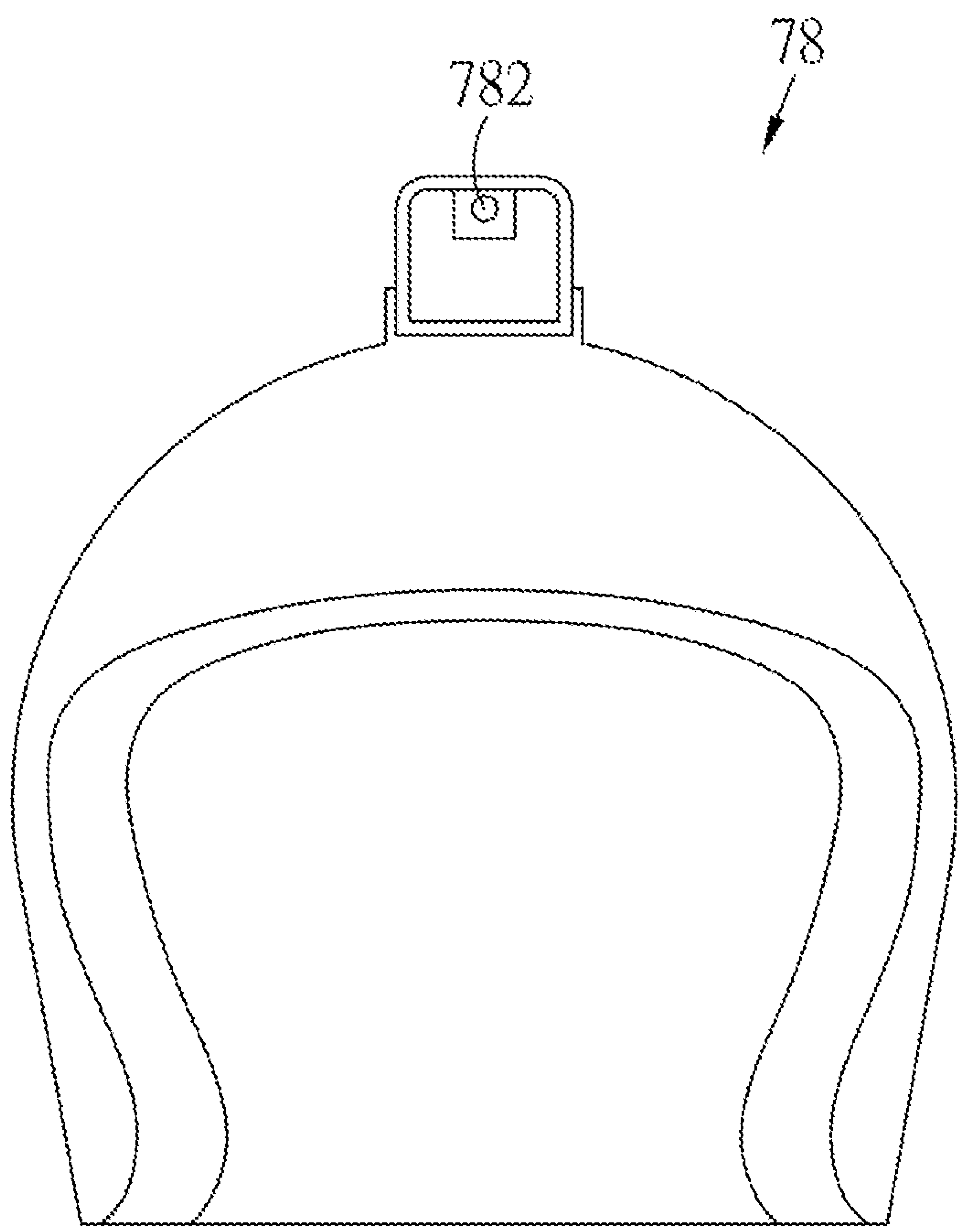

FIG. 41

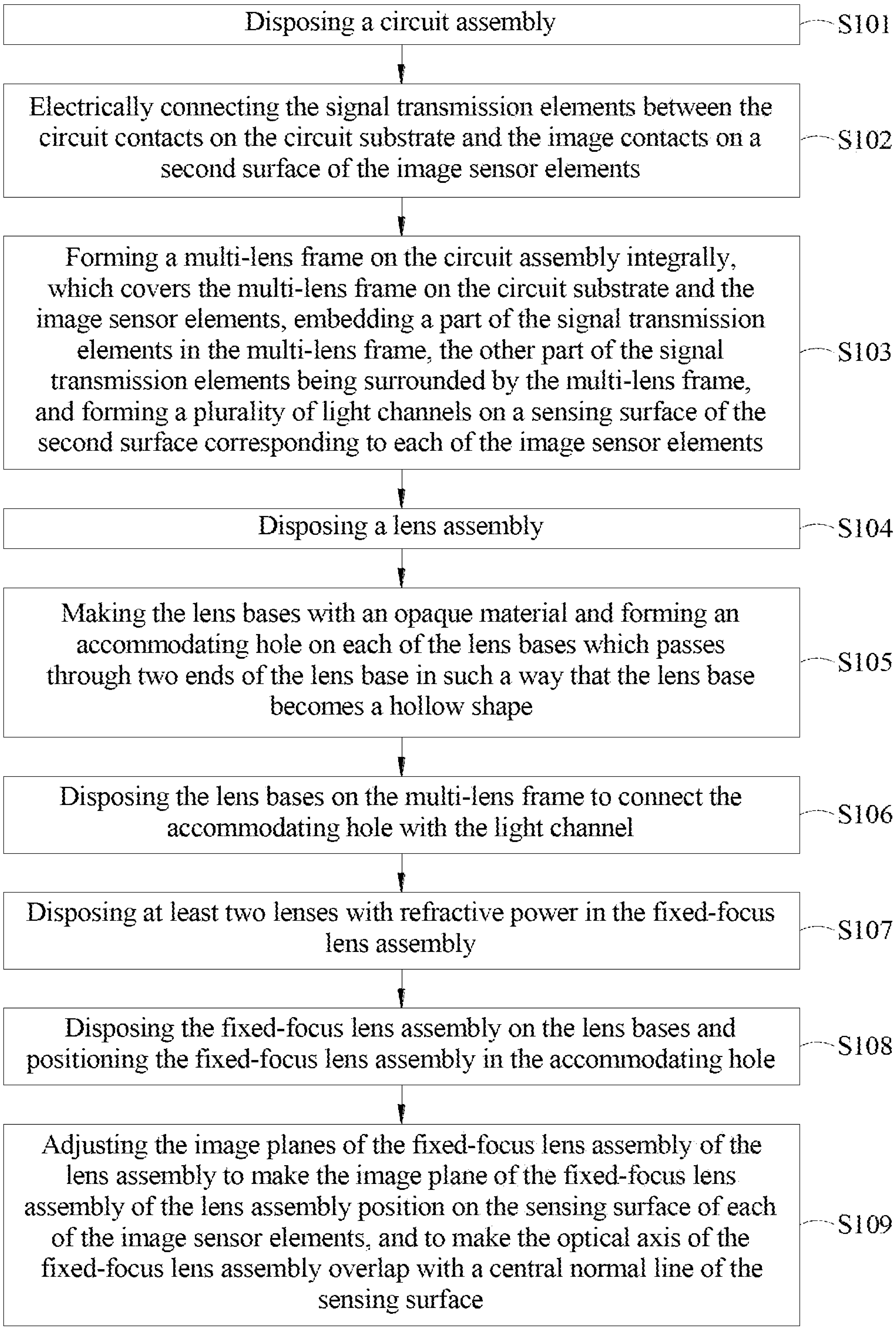
Disposing a circuit assembly
S101
Electrically connecting the signal transmission elements between the circuit contacts on the circuit substrate and the image contacts on a second surface of the image sensor elements
S102
Forming a multi-lens frame on the circuit assembly integrally, which covers the multi-lens frame on the circuit substrate and the image sensor elements, embedding a part of the signal transmission elements in the multi-lens frame, the other part of the signal transmission elements being surrounded by the multi-lens frame, and forming a plurality of light channels on a sensing surface of the second surface corresponding to each of the image sensor elements
S103
Disposing a lens assembly
S104
Making the lens bases with an opaque material and forming an accommodating hole on each of the lens bases which passes through two ends of the lens base in such a way that the lens base becomes a hollow shape
S105
Disposing the lens bases on the multi-lens frame to connect the accommodating hole with the light channel
S106
Disposing at least two lenses with refractive power in the fixed-focus lens assembly
S107
Disposing the fixed-focus lens assembly on the lens bases and positioning the fixed-focus lens assembly in the accommodating hole
S108
Adjusting the image planes of the fixed-focus lens assembly of the lens assembly to make the image plane of the fixed-focus lens assembly of the lens assembly position on the sensing surface of each of the image sensor elements, and to make the optical axis of the fixed-focus lens assembly overlap with a central normal line of the sensing surface
S109

FIG. 42

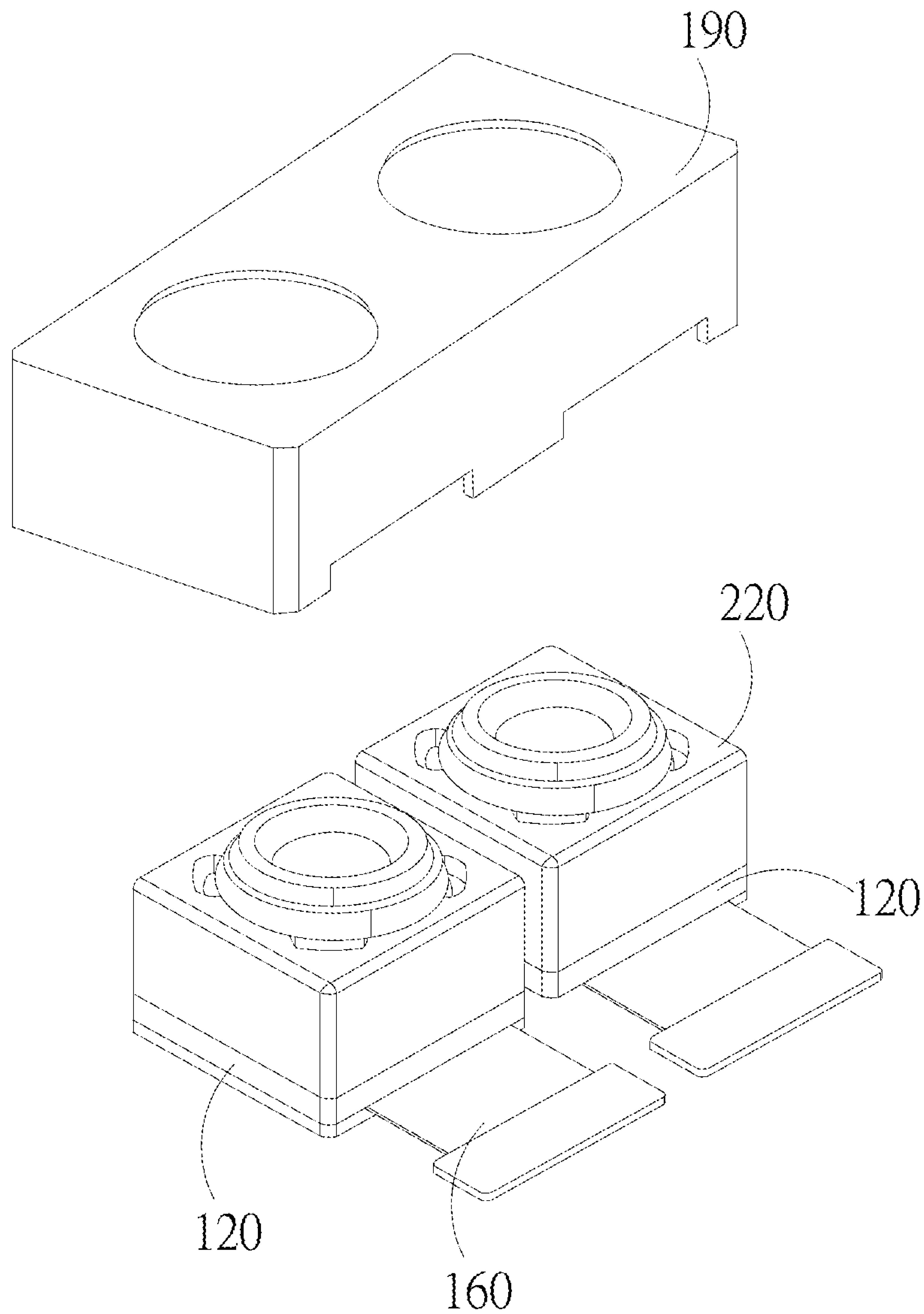

FIG. 43

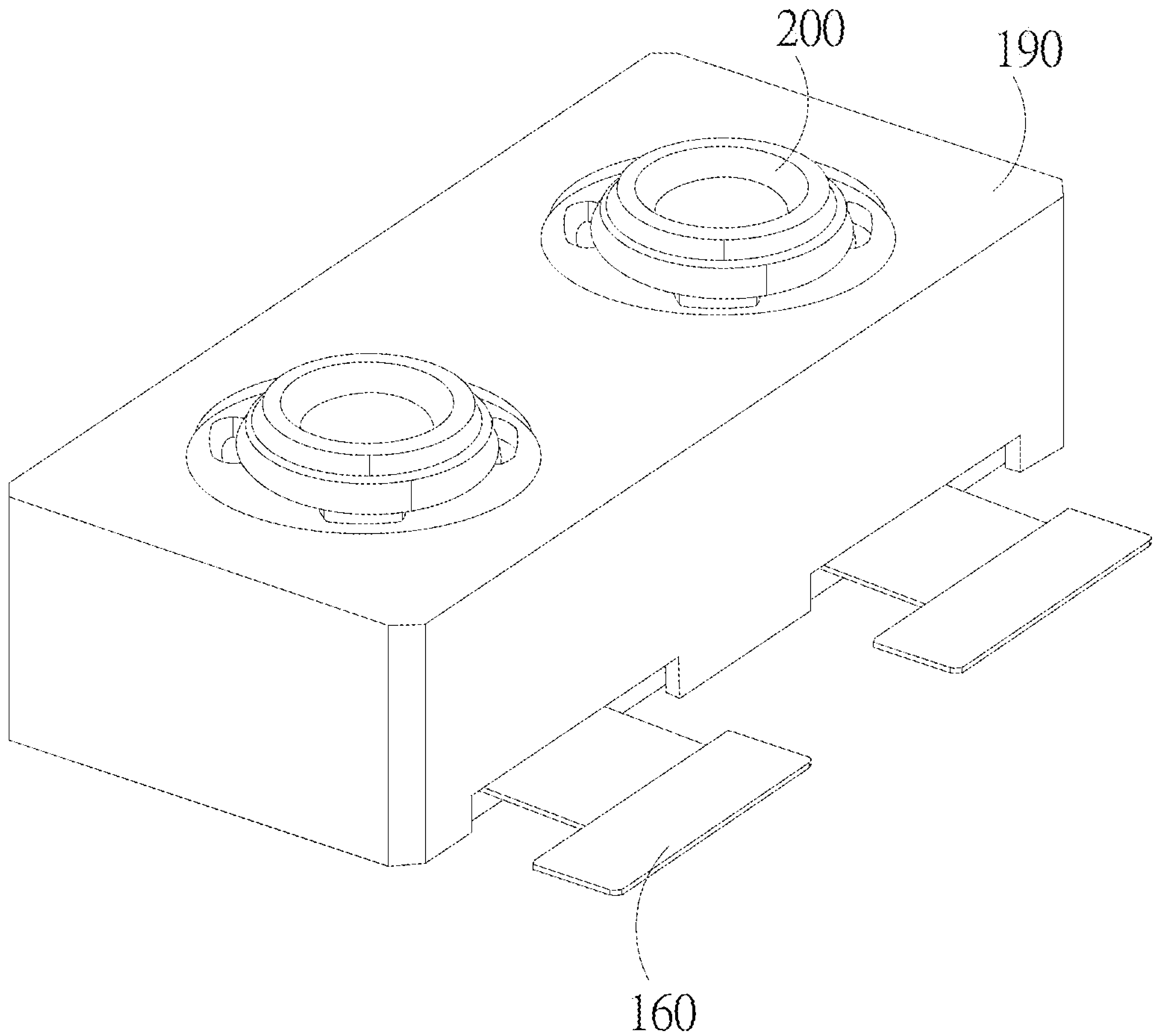

FIG. 44

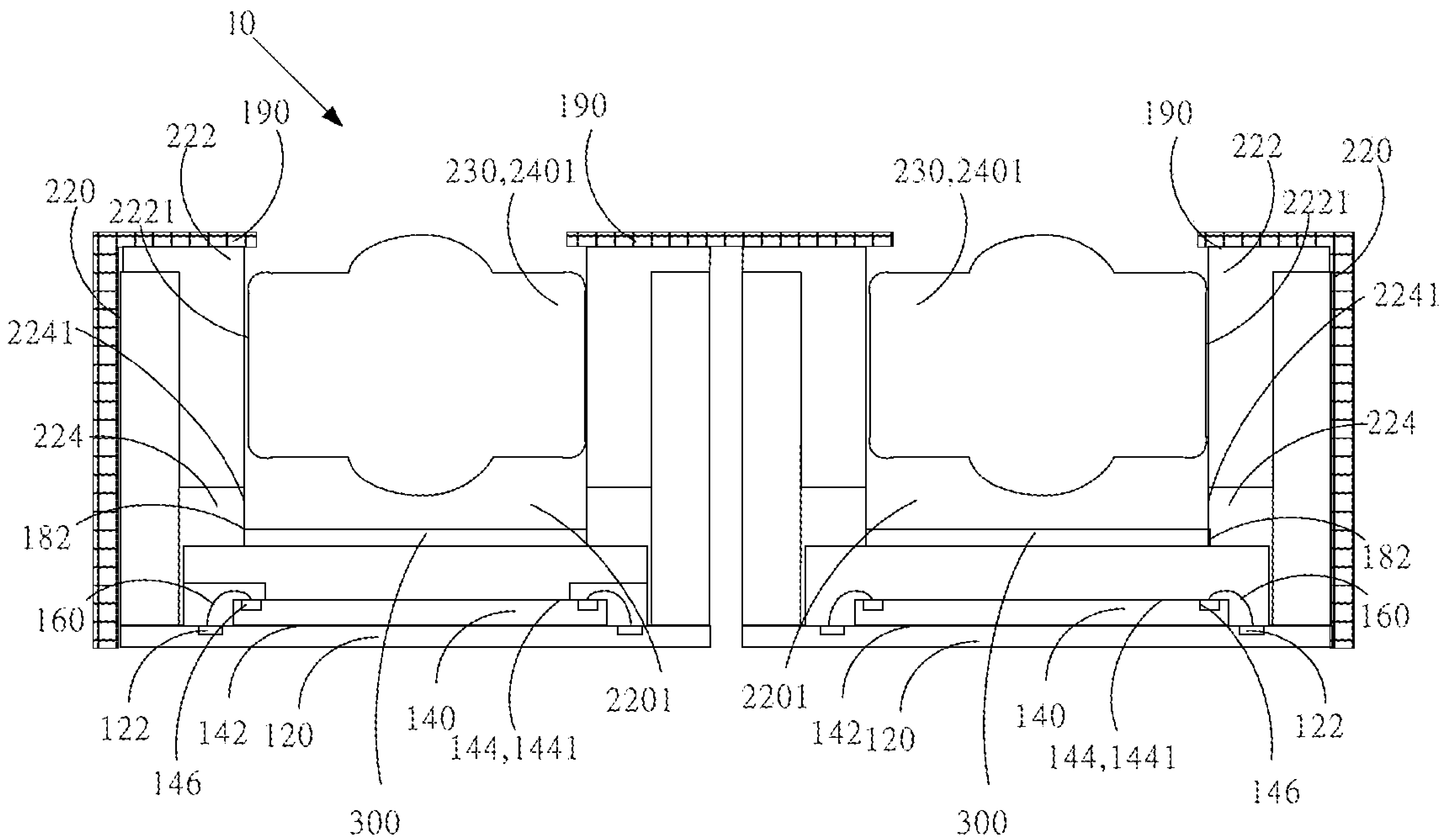
10
190
222
220
2221
2241
224
182
160
122
146
142
120
300
140
144,1441
2201
230,2401
190
230,2401
2201
142
120
300
140
144,1441
146
122
160
182
224
2241
220
2221
222
190

FIG. 45

OPTICAL IMAGE CAPTURING MODULE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Taiwan Patent Application No. 107128612 filed on Aug. 16, 2018, in the Taiwan Intellectual Property Office, the content of which is hereby incorporated by reference in its entirety for all purposes.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical image capturing module, more particularly to an optical image capturing module which provides fixed-focus lens assemblies, has a multi-lens frame manufactured integrally, and has a part of signal transmission elements embedded in the multi-lens frame.

2. Description of the Related Art

With respect to the assembly of video-recording devices at present, many problems have been identified but not solved yet, especially the video-recording devices with multiple lenses. Due to the use of multiple lenses, there is a dramatic impact on image quality if an optical axis cannot be accurately aimed at a CMOS active pixel sensor for calibration in the process of assembling and manufacturing image quality.

Moreover, to meet higher photographic requirements, video-recording devices need to have more lenses, four at the least. Therefore, how to include at least four lenses and still have a fine imaging quality is a critical issue that needs to be addressed. Therefore, there is a need for an optical image capturing module to solve the problem as mentioned above.

SUMMARY OF THE INVENTION

In view of the aforementioned problems, the present invention provides an optical image capturing module and a manufacturing method thereof so that an optical axis of each fixed-focus lens assembly may overlap a central normal line of the sensing surface and light is able to pass through each fixed-focus lens assembly in the accommodating hole, pass through the light channel, and be emitted to the sensing surface to ensure image quality. Additionally, the signal transmission elements, such as gold wire, may be embedded in the integrally-manufactured multi-lens frame to avoid deformation of components in the packing process that may lead to many problems like short-circuiting. The overall size of the optical module may also be minimized.

On the basis of the aforementioned purpose, the present disclosure provides an optical image capturing module including a circuit assembly and a lens assembly. The circuit assembly may include a circuit substrate, a plurality of image sensor elements, a plurality of signal transmission elements, and a multi-lens frame. The circuit substrate may include a plurality of circuit contacts. Each of the image sensor elements may include a first surface and a second surface. The first surface may be connected to the circuit substrate. The second surface may have a sensing surface and a plurality of image contacts. The plurality of signal transmission elements may be electrically connected between the plurality of circuit contacts on the circuit substrate and each of the plurality of image contacts of each of the image sensor elements. The multi-lens frame may be manufactured integrally and be covered on the circuit substrate and the image sensing elements. The multi-lens frame may be manufactured integrally and covered on the circuit substrate and the image sensor elements. A part of the signal transmission elements may be embedded in the multi-lens frame, whereas the other part may be surrounded by the multi-lens frame. The positions corresponding to the sensing surface of the plurality of image sensor elements may have a plurality of light channels. The lens assembly may include a plurality of lens bases and a plurality of fixed-focus lens assemblies. The lens bases may be made of an opaque material and have an accommodating hole passing through two ends of the lens bases so that the lens bases become hollow, and the lens bases may be disposed on the multi-lens frame so that the accommodating hole is connected to the light channel. Each of the fixed-focus lens assemblies may have at least two lenses with refractive power, be disposed on the lens base, and be positioned in the accommodating hole. The image planes of each of the fixed-focus lens assemblies may be disposed on the sensing surface. An optical axis of each of the fixed-focus lens assemblies may overlap the central normal line of the sensing surface in such a way that light is able to pass through each of the fixed-focus lens assemblies in the accommodating hole and be emitted to the sensing surface. The fixed-focus lens assembly further satisfies the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0\text{ deg} < HAF \leq 150\text{ deg};$$

$$0\text{ mm} < PhiD \leq 18\text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99;\text{ and}$$

$$0.9 \leq 2(ARE/HEP) \leq 2.0;$$

Wherein, f is the focal length of the fixed-focus lens assembly. HEP is the entrance pupil diameter of the fixed-focus lens assembly. HAF is the half maximum angle of view of the fixed-focus lens assembly. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly. PhiA is the maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of the image plane. ARE is the arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

Preferably, the lens base may include a lens barrel and a lens holder. The lens barrel may have an upper hole which passes through two ends of the lens barrel, and the lens bolder may have a lower hole which passes through two ends of the lens holder. The lens barrel may be disposed in the lens holder and be positioned in the lower hole in such a way that the upper hole and the lower hole are connected to constitute the accommodating hole. The lens holder may be fixed on the multi-lens frame in such a way that the image sensor element is positioned in the lower hole. The upper hole of the lens barrel may face the sensing surface of the image sensor element. The fixed-focus lens assembly may be disposed in the lens barrel and be positioned in the upper hole. PhiD is the maximum value of a minimum side length of an outer periphery of the lens holder perpendicular to the optical axis of the fixed-focus lens assembly.

Preferably, the optical image capturing module may further include at least one data transmission line electrically connected to the circuit substrate and transmitting a plurality of sensing signals generated from each of the plurality of image sensor elements.

Preferably, the plurality of image sensor elements may sense a plurality of color images.

Preferably, at least one of the image sensor elements may sense a plurality of black-and-white images and at least one of the image sensor elements may sense a plurality of color images.

Preferably, the optical image capturing module may further include a plurality of IR-cut filters, and the IR-cut filter may be disposed in the lens base, be positioned in the accommodating hole, and be located on the image sensor element.

Preferably, the optical image capturing module may further include a plurality of IR-cut filters, and the IR-cut filter may be disposed in the lens barrel or the lens holder and be positioned on the image sensor element.

Preferably, the optical image capturing module in the present invention may further include a plurality of IR-cut filters, and the lens base may include a filter holder. The filter holder may have a filter hole which passes through two ends of the filter holder. The IR-cut filter may be disposed in the filter holder and be positioned in the filter hole, and the filter holder may correspond to positions of the plurality of light channels and be disposed on the multi-lens frame in such a way that the IR-cut filter is positioned on the image sensor element.

Preferably, the lens base may include a lens barrel and a lens holder. The lens barrel may have an upper hole which passes through two ends of the lens barrel, and the lens holder may have a lower hole which passes through two ends of the lens holder. The lens barrel may be disposed in the lens holder and be positioned in the lower hole. The lens holder may be fixed on the filter holder. The lower hole, the upper hole, and the filter hole are connected to constitute the accommodating hole in such a way that the image sensor element is positioned in the filter hole. The upper hole of the lens barrel faces the sensing surface of the image sensor element. In addition, the fixed-focus lens assembly may be disposed in the lens barrel and positioned in the upper hole.

Preferably, materials of the multi-lens frame may include any one of metal, conducting material, and alloy, or any combination thereof.

Preferably, materials of the multi-lens frame may include any one of thermoplastic resin, plastic used for industries, insulating material, or any combination thereof.

Preferably, the multi-lens frame may include a plurality of camera lens holders, each of the camera lens holders may have the light channel and a central axis, and a distance between the central axes of adjacent camera lens holders is a value between 2 mm and 200 mm.

Preferably, a reflectance of the multi-lens frame is less than 5% in a light wavelength range of 435-660 nm.

Preferably, the multi-lens frame may have an outer surface, a first inner surface, and a second inner surface. The outer surface may extend from an edge of the circuit substrate, and have a tilted angle α with a central normal line of the sensing surface, and α is in a value between 1° to 30°. The first inner surface is an inner surface of the light channel, the first inner surface has a tilted angle β with a central normal line of the sensing surface, and β is in a value between 1° to 45°. The second inner surface extends from the top of the circuit substrate to the light channel, and has a tilted angle γ with a central normal line of the sensing surface, and γ is in a value between 1° to 3°.

Preferably, the plurality of fixed-focus lens assemblies include a first lens assembly and a second lens assembly. A field of view (FOV) of the second lens assembly is larger than that of the first lens assembly.

Preferably, the plurality of fixed-focus lens assemblies include a first lens assembly and a second lens assembly. The focal length of the first lens assembly is larger than that of the second lens assembly.

Preferably, the optical image capturing module has at least three fixed-focus lens assemblies, including a first lens assembly, a second lens assembly, and a third lens assembly. The field of view (FOV) of the second lens assembly is larger than that of the first lens assembly. The field of view (FOV) of the second lens assembly is larger than 46°, and each of the plurality of image sensor elements correspondingly receiving lights from the first lens assembly and the second lens assembly senses a plurality of color images.

Preferably, the optical image capturing module has at least three fixed-focus lens assemblies, including a first lens assembly, a second lens assembly, and a third lens assembly. A focal length of the first lens assembly is larger than that of the second lens assembly, and each of the plurality of image sensor elements correspondingly receiving lights from the first lens assembly and the second lens assembly senses a plurality of color images.

Preferably, the optical image capturing module further satisfies the following conditions:

$0<(TH1+TH2)HOI\leq0.95$; wherein, TH1 is the maximum thickness of the lens holder. TH2 is the minimum thickness of the lens barrel. HOI is the maximum image height perpendicular to the optical axis on the image plane.

Preferably, the optical image capturing module further satisfies the following conditions:

$0\text{ mm}<TH1+TH2\leq1.5\text{ mm}$; wherein, TH1 is the maximum thickness of the lens holder. TH2 is the minimum thickness of the lens barrel.

Preferably, the optical image capturing module further satisfy the following conditions:

$0<(TH1+TH2)/HOI\leq0.95$; wherein, TH1 is the maximum thickness of the lens holder. TH2 is the minimum thickness of the lens barrel. HOI is the maximum image height perpendicular to the optical axis on the image plane.

Preferably, the optical image capturing module further satisfies the following conditions:

$0.9\leq ARS/EHD\leq2.0$; wherein ARS is the arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly and ending at a maximum effective half diameter point of the lens surface. EHD is the maximum effective half diameter of any surfaces of any lenses in the fixed-focus lens assembly.

Preferably, the following conditions are satisfied:

$PLTA\leq100\ \mu m$; $PSTA\leq100\ \mu m$; $NLTA\leq100\ \mu m$; and $NSTA\leq100\ \mu m$. $SLTA\leq100\ \mu m$; $SSTA\leq100\ \mu m$. Wherein, HOI is defined as the maximum image height perpendicular to the optical axis on the image plane; PLTA is the lateral aberration of the longest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; PSTA is the lateral aberration of the shortest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; NLTA is the lateral aberration of the longest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; NSTA is the lateral aberration of the shortest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; SLTA is the lateral aberration of the longest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI; SSTA is the lateral aberration of the shortest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI.

Preferably, the fixed-focus lens assembly may include four lenses with refractive power, which are a first lens, a second lens, a third lens, and a fourth lens sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly satisfies the following condition: 0.1≤InTL/HOS≤0.95. Specifically, HOS is the distance from an object side surface of the first lens to the imaging surface on an optical axis. InTL is the distance on the optical axis from an object side surface of the first lens to an image side surface of the fourth lens.

Preferably, the fixed-focus lens assembly may include five lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, and a fifth lens sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly satisfies the following condition: 0.1≤InTL/HOS≤10.95. Specifically, HOS is the distance from an object side surface of the first lens to the imaging surface on an optical axis. InTL is the distance from an object side surface of the first lens to an image side surface of the fifth lens on an optical axis.

Preferably, the fixed-focus lens assembly may include six lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, a fifth lens, and a sixth lens sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly satisfies the following condition: 0.1≤InTL/HOS≤0.95. HOS is the distance on the optical axis from an object side surface of the first lens to the image plane. InTL is the distance on the optical axis from an object side surface of the first lens to an image side surface of the sixth lens.

The fixed-focus lens assembly may include seven lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, a fifth lens, a sixth lens, and a seventh lens sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly satisfies the following condition: 0.1≤InTL/HOS≤0.95. HOS is the distance from an object side surface of the first lens to the imaging surface on an optical axis. InTL is the distance on the optical axis from an object side surface of the first lens to an image side surface of the seventh lens.

Preferably, the optical image capturing module in the present invention may be applied to one of an electronic portable device, an electronic wearable device, an electronic monitoring device, electronic information device, electronic communication device, machine vision device, vehicle electronic device, and combinations thereof.

On the basis of the purpose as mentioned above, the present invention further provides a manufacturing method of an optical image capturing module, including:

disposing a circuit assembly including a circuit substrate, a plurality of image sensor elements, and a plurality of signal transmission elements;

electrically connecting the plurality of signal transmission elements between the plurality of circuit contacts on the circuit substrate and the plurality of image contacts on a second surface of each of the image sensor elements;

forming a multi-lens frame on the circuit assembly integrally, which covers the multi-lens frame on the circuit substrate and the image sensor elements, embedding a part of the signal transmission elements in the multi-lens frame, the other part of the signal transmission elements being surrounded by the multi-lens frame, and forming a plurality of light channels on a sensing surface of the second surface corresponding to each of the image sensor elements;

disposing a lens assembly, which includes lens bases and plurality of fixed-focus lens assembly;

making the plurality of lens bases with opaque material and forming an accommodating hole on each of the lens bases which passes through two ends of the lens base in such a way that the lens base becomes a hollow shape;

disposing the lens bases on the multi-lens frame to connect the accommodating hole with the light channel;

disposing at least two lenses with refractive power in each of the fixed-focus lens assemblies and making each of the fixed-focus lens assemblies satisfy the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0 \leq (ARE/HEP) \leq 2.0;$$

In the conditions above, f is the focal length of the fixed-focus lens assembly. HEP is the entrance pupil diameter of the fixed-focus lens assembly. HAF is the half maximum angle of view of the fixed-focus lens assembly. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base perpendicular to an optical axis of the fixed-focus lens assembly. PhiA is the maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of an image plane. ARE is the arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

disposing each of the fixed-focus lens assemblies on the lens bases and positioning each of the fixed-focus lens assemblies in the accommodating hole;

adjusting the image planes of each of the fixed-focus lens assemblies of the lens assembly to make the image plane of each of the fixed-focus lens assemblies of the lens assembly respectively position on the sensing surface of each of the image sensor elements, and to make the optical axis of each of the fixed-focus lens assemblies overlap with a central normal line of the sensing surface; and

The terms for the lens parameters in the embodiments in the present invention and the symbols thereof are listed in detail below as references for the following descriptions.

The Lens Parameters Related to Length and Height:

HOI denotes the maximum imaging height of the optical image capturing module as shown. HOS denotes the height (a distance from an object side surface of the first lens to the imaging surface on an optical axis) of the optical image capturing module. InTL denotes a distance on the optical axis from an object side surface of the first lens to an image side surface of the last lens. InS denotes a distance from the light diaphragm (aperture) to the image plane on the optical axis. IN12 denotes the distance between the first lens and the second lens of the optical image capturing module. TP1 denotes the thickness of the first lens of the optical image capturing module on the optical axis.

The Lens Parameters Related to Materials:

NA1 denotes the dispersion coefficient of the first lens of the optical image capturing module; Nd1 denotes the refractive index of the first lens.

The Lens Parameters Related to a Field of View:

The field of view is shown as AF. Half of the field of view is shown as AF. The main ray angle is shown as MRA.

The Lens Parameters Related to the Exit and Incident Pupil:

HEP denotes the entrance pupil diameter of the optical image capturing system. The maximum effective half diameter position of any surface of single lens refers to the vertical height between the effective half diameter (EHD) and the optical axis where the incident light of the maximum view angle of the system passes through the farthest edge of the entrance pupil on the EHD of the surface of the lens. For instance, EHD11 denotes the maximum effective half diameter of the object side surface of the first lens. EHD12 denotes the maximum effective half diameter of the image side surface of the first lens. EHD21 denotes the maximum effective half diameter of the object side surface of the second lens. EHD12 denotes the maximum effective half diameter of the image side surface of the second lens. The maximum effective half diameter of any surface of the rest lenses in the optical image capturing module may be deducted on this basis. PhiA denotes the maximum diameter of the image side surface of the lens closest to the image plane in the optical image capturing module, satisfying the equation PhiA=2*EHD. If the surface is aspheric, the ending point of the maximum effective diameter is the ending point which includes the aspheric surface. An ineffective half diameter (IHD) of any surface of a single lens denotes a surface section of an ending point (If the surface is aspheric, the surface has the ending point of the aspheric coefficient.) extending from the direction away from the optical axis to an effective half diameter on the same surface. PhiB denotes the maximum diameter of the image side surface of the lens closest to the image plane in the optical image capturing module, satisfying the equation PhiB=2*(the maximum effective half diameter EHD+the maximum ineffective half diameter IHD)=PhiA+2*(the maximum ineffective half diameter IHD).

PhiA, also called optical exit pupil, denotes the maximum effective diameter of the image side surface of the lens nearest to the image plane (image space) in the optical image capturing module. PhiA3 is used when the optical exit pupil is located on the image side surface of the third lens. PhiA4 is used when the optical exit pupil is located on the image side surface of the fourth lens. PhiA5 is used when the optical exit pupil is located on the image side surface of the fifth lens. PhiA6 is used when the optical exit pupil is located on the image side surface of the sixth lens. The optical exit pupil thereof may be deducted when the optical image capture module has lenses with different refractive powers.

PMR denotes the pupil opening ratio of the optical image capturing module, which satisfies the condition PMR=PhiA/HEP.

The Parameters Related to a Lens Surface Arc Length and a Surface Outline:

The arc length of the maximum effective half diameter of any surface of a single lens denotes the arc length between two points as the maximum effective diameter along an outline of the lens surface, starting from an intersection point of the lens surface and the optical axis in the optical image capturing module, and ending at point of the maximum effective half diameter, shown as ARS. For instance, ARS11 denotes the arc length of the maximum effective half diameter of the object side surface of the first lens. ARS12 denotes the arc length of the maximum effective half diameter of the image side surface of the first lens. ARS21 denotes the arc length of the maximum effective half diameter of the object side surface of the second lens. ARS22 denotes the arc length of the maximum effective half diameter of the image side surface of the second lens. The arc length of the maximum effective half diameter of any surface of the rest lenses in the optical image capturing module may be deducted on this basis.

The arc length of half the entrance pupil diameter (HEP) of any surface of a single lens denotes the arc length of two points as half the entrance pupil diameter (HEP) along an outline of the lens surface, starting from an intersection point of the lens surface and the optical axis of in the optical image capturing module, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter, shown as ARE. For instance, ARE11 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the first lens. ARE12 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the first lens. ARE21 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the second lens. ARE22 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the second lens. The arc length of half the entrance pupil diameter (HEP) of any surface of the rest lenses in the optical image capturing module may be deducted on this basis.

The Parameters Related to the Lens Depth:

InRS61 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the object side surface of the sixth lens (a depth of the maximum effective half diameter). InRS62 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the image side surface of the sixth lens (the depth of the maximum effective half diameter). The depths of the maximum effective half diameters (sinkage values) of the object side surfaces or the image side surfaces of the other lenses are shown in the same manner as described above.

The Parameters Related to the Lens Type:

Critical point C denotes the section point perpendicular to the optical axis in addition to the intersection point with the optical axis on a particular lens surface. For instance, HVT51 is the distance perpendicular to the optical axis between a critical point CSI on an object side surface of the fifth lens and the optical axis. HVT52 is the distance perpendicular to the optical axis between a critical point C52 on an image side surface of the fifth lens and the optical axis. HVT61 is the distance perpendicular to the optical axis between a critical point C61 on an object side surface of the sixth lens and the optical axis. HVT62 is the distance perpendicular to the optical axis between a critical point C62 on an image side surface of the sixth lens and the optical axis. The critical points on the object side surfaces or the image side surfaces of other lenses and the vertical distance from the points to the optical axis are shown in the same manner as described above.

IF711 denotes the inflection point closest to the optical axis on the object side surface of the seventh lens. The sinkage value of the point is SGI711. SGI711 also denotes the horizontal displacement distance from the intersection point of the object side surface of the seventh lens on the optical axis to the inflection point of the object side surface of the seventh lens closest to the optical axis, which is parallel to the optical axis. HIF711 is the vertical distance from the point IF711 to the optical axis. IF721 denotes the inflection point closest to the optical axis on the image side surface of the seventh lens. The sinkage value of the point is SGI721. SGI721 also denotes the horizontal displacement distance from the intersection point of the image side surface of the seventh lens on the optical axis to the inflection point of the image side surface of the seventh lens closest to the optical axis, which is parallel to the optical axis. HIF721 is the vertical distance from the point IF721 to the optical axis.

IF712 denotes the inflection point second closest to the optical axis on the object side surface of the seventh lens. The sinkage value of the point is SGI712. SGI712 also denotes the horizontal displacement distance from the intersection point of the object side surface of the seventh lens on the optical axis to the inflection point of the object side surface of the seventh lens second closest to the optical axis, which is parallel to the optical axis. HIF712 is the vertical distance from the point IF712 to the optical axis. IF722 denotes the inflection point second closest to the optical axis on the image side surface of the seventh lens. The sinkage value of the point is SGI722. SGI722 also denotes the horizontal displacement distance from the intersection point of the image side surface of the seventh lens on the optical axis to the inflection point of the image side surface of the seventh lens second closest to the optical axis, which is parallel to the optical axis. HIF722 is the vertical distance from the point IF722 to the optical axis.

IF713 denotes the inflection point third closest to the optical axis on the object side surface of the seventh lens. The sinkage value of the point is SGI713. SGI713 also denotes the horizontal displacement distance from the intersection point of the object side surface of the seventh lens on the optical axis to the inflection point of the object side surface of the seventh lens third closest to the optical axis, which is parallel to the optical axis. HIF713 is the vertical distance from the point IF713 to the optical axis. IF723 denotes the inflection point third closest to the optical axis on the image side surface of the seventh lens. The sinkage value of the point is SGI723. SGI723 also denotes the horizontal displacement distance from the intersection point of the image side surface of the seventh lens on the optical axis to the inflection point of the image side surface of the seventh lens third closest to the optical axis, which is parallel to the optical axis. HIF723 is the vertical distance from the point IF723 to the optical axis.

IF714 denotes the inflection point fourth closest to the optical axis on the object side surface of the seventh lens. The sinkage value of the point is SGI714. SGI714 also denotes the horizontal displacement distance from the intersection point of the object side surface of the seventh lens on the optical axis to the inflection point of the object side surface of the seventh lens fourth closest to the optical axis, which is parallel to the optical axis. HIF714 is the vertical distance from the point IF714 to the optical axis. IF724 denotes the inflection point fourth closest to the optical axis on the image side surface of the seventh lens. The sinkage value of the point is SGI724. SGI724 also denotes the horizontal displacement distance from the intersection point of the image side surface of the seventh lens on the optical axis to the inflection point of the image side surface of the seventh lens fourth closest to the optical axis, which is parallel to the optical axis. HIF724 is the vertical distance from the point IF724 to the optical axis.

The inflection points on the object side surfaces or the image side surfaces of other lenses and the vertical distance from the points to the optical axis or the sinkage value thereof are shown in the same manner as described above.

The Lens Parameters Related to Aberrations:

ODT denotes the optical distortion of the optical image capturing module. TDT denotes the TV distortion, which may be further defined by the degree of the aberration displacement between the image of 50% and 100%. DFS denotes the spherical aberration displacement. DFC denotes the comet aberration displacement.

The present invention provides an optical image capturing module. Wherein, an inflection point may be disposed on the object side surface or the image side surface of the six lens, which may effectively adjust the angle at which each field of view is incident on the sixth lens and make correction on the optical distortion and the TV distortion. In addition, the surface of the sixth lens may be equipped with a greater light path regulating ability, thus enhancing the image quality.

The arc length of any surface of a single lens within the maximum effective half diameter affects the surface's ability to correct the aberration and the optical path differences between each of the fields of view. The longer the arc length is, the better the ability to correct the aberration will be. However, difficulties may be found in the manufacturing process. Therefore, it is necessary to control the arc length of any surface of a single lens within the maximum effective half diameter, especially the ratio (ARS/TP) between the arc length (ARS) of the surface within the maximum effective half diameter and the thickness (TP) of the lens to which the surface belongs on the optical axis. For instance, ARS11 denotes the arc length of the maximum effective half diameter of the object side surface of the first lens. TP1 denotes the thickness of the first lens on the optical axis. The ratio between the two is ARS11/TP1. ARS12 denotes the arc length of the maximum effective half diameter of the image side surface of the first lens. The ratio between ARS12 and TP1 is ARS12/TP1. ARS21 denotes the arc length of the maximum effective half diameter of the object side surface of the second lens. TP2 denotes the thickness of the second lens on the optical axis. The ratio between the two is ARS21/TP2. ARS22 denotes the arc length of the maximum effective half diameter of the image side surface of the second lens. The ratio between ARS22 and TP2 is ARS12/TP2. The ratio between the arc length of the maximum effective half diameter of any surface of the rest lenses in the optical image capturing module and the thickness (TP) of the lens to which the surface belongs on the optical axis may be deducted on this basis. In addition, the optical image capturing module further satisfies the following conditions:

PLTA is the lateral aberration of the longest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI. PSTA is the lateral aberration of the shortest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI. NLTA is the lateral aberration of the longest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI. NSTA is the lateral aberration of the shortest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI. SLTA is the lateral aberration of the longest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI; SSTA is the lateral aberration of the shortest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI. In addition, the optical image capturing module further satisfies the following conditions: PLTA≤100 μm; PSTA≤100 μm; NLTA≤100 μm; NSTA≤100 μm; SLTA≤100 μm; SSTA 100 μm; |TDT|<250%; 0.1≤InTL/HOS≤0.95; and 0.2≤InS/HOS≤1.1.

MTFQ0 denotes the modulation conversion transferring rate of visible light on the imaging surface by the optical axis at a spatial frequency of 110 cycles/mm. MTFQ3 denotes the modulation conversion transferring rate of visible light on the imaging surface by 0.3HOI at a spatial frequency of 110 cycles/mm. MTFQ7 denotes the modulation conversion transferring rate of visible light on the imaging surface by 0.7HOI at a spatial frequency of 110 cycles/mm. In addition, the optical image capturing module further satisfies the following conditions: MTFQ0≥0.2; MTFQ3≥0.01; and MTFQ7≥0.01.

The arc length of any surface of a single lens within the height of half the entrance pupil diameter (HEP) particularly affects the surface's ability to correct the aberration and the optical path differences between each of the fields of view at the shared area. The longer the arc length is, the better the ability to correct the aberration will be. However, difficulties may be found in the manufacturing process. Therefore, it is necessary to control the arc length of any surface of a single lens within the height of half the entrance pupil diameter (HEP), especially the ratio (ARE/TP) between the arc length (ARE) of the surface within the height of the half the entrance pupil diameter (HEP) and the thickness (TP) of the lens to which the surface belongs on the optical axis. For instance, ARE11 denotes the arc length of the height of the half the entrance pupil diameter (HEP) of the object side surface of the first lens. TP1 denotes the thickness of the first lens on the optical axis. The ratio between the two is ARE11/TP1. ARE12 denotes the arc length of the height of the half the entrance pupil diameter (HEP) of the image side surface of the first lens. The ratio between ARE12 and TP1 is ARE12/TP1. ARE21 denotes the arc length of the height of the half the entrance pupil diameter (HEP) of the object side surface of the second lens. TP2 denotes the thickness of the second lens on the optical axis. The ratio between the two is ARE21/TP2. ARE22 denotes the arc length of the height of the half the entrance pupil diameter (HEP) of the image side surface of the second lens. The ratio between ARE22 and TP2 is ARE22/TP2. The ratio between the are length of the height of the half the entrance pupil diameter (HEP) of any surface of the rest lenses in the optical image capturing module and the thickness (TP) of the lens to which the surface belongs on the optical axis may be deducted on this basis.

On the basis of the purpose as mentioned above, the present invention further provides an optical image capturing module including a circuit assembly, a lens assembly, and a multi-lens outer frame. The circuit assembly may include a circuit substrate, a plurality of image sensor elements, and a plurality of signal transmission elements. The circuit substrate may include a plurality of circuit contacts. Each of the image sensor elements may include a first surface and a second surface. The first surface may be connected to the circuit substrate. The second surface may have a sensing surface and a plurality of image contacts. The plurality of signal transmission elements may be electrically connected between the plurality of circuit contacts on the circuit substrate and each of the plurality of image contacts of each of the image sensor elements. The lens assembly may include a plurality of lens bases and a plurality of fixed-focus lens assemblies. The lens bases may be made of an opaque material and have an accommodating hole passing through two ends of the lens bases so that the lens bases become hollow, and the lens bases may be disposed on the circuit substrate. Each of the fixed-focus lens assemblies may have at least two lenses with refractive power, be disposed on the lens base, and be positioned in the accommodating hole. The image planes of each of the fixed-focus lens assemblies may be disposed on the sensing surface. An optical axis of each of the fixed-focus lens assemblies may overlap the central normal line of the sensing surface in such a way that light is able to pass through each of the fixed-focus lens assemblies in the accommodating hole and be emitted to the sensing surface. Each of the lens bases is respectively fixed to the multi-lens outer frame in order to form a whole body.

The fixed-focus lens assembly further satisfy the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0.9 \leq 2(ARE/HEP) \leq 2.0;$$

Wherein, f is the focal length of the fixed-focus lens assembly. HEP is the entrance pupil diameter of the fixed-focus lens assembly. HAF is the half maximum angle of view of the fixed-focus lens assembly. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly. PhiA is the maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of the image plane. ARE is the arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of the configuration according to the embodiment in the present invention.

FIG. **2** is a schematic diagram of the multi-lens frame according to the embodiment in the present invention.

FIG. **3** is a schematic diagram of the parameter description according to the embodiment in the present invention.

FIG. **4** is a first schematic implementation diagram according to the embodiment in the present invention.

FIG. **5** is a second schematic implementation diagram according to the embodiment in the present invention.

FIG. **6** is a third schematic implementation diagram according to the embodiment in the present invention.

FIG. **7** is a fourth schematic implementation diagram according to the embodiment in the present invention.

FIG. **8** is a fifth schematic implementation diagram according to the embodiment in the present invention.

FIG. **9** is a sixth schematic implementation diagram according to the embodiment in the present invention.

FIG. **10** is a seventh schematic implementation diagram according to the embodiment in the present invention.

FIG. **11** is an eighth schematic implementation diagram according to the embodiment in the present invention.

FIG. **12** is a ninth schematic implementation diagram according to the embodiment in the present invention.

FIG. **13** is a tenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **14** is an eleventh schematic implementation diagram according to the embodiment in the present invention.

FIG. **15** is a twelfth schematic implementation diagram according to the embodiment in the present invention.

FIG. **16** is a thirteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **17** is a fourteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **18** is a fifteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **19** is a sixteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **20** is a seventeenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **21** is an eighteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **22** is a schematic diagram of the first optical embodiment according to the embodiment in the present invention.

FIG. **23** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the first optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **24** is a schematic diagram of the second optical embodiment according to the embodiment in the present invention.

FIG. **25** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the second optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **26** is a schematic diagram of the third optical embodiment according to the embodiment in the present invention.

FIG. **27** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the third optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **28** is a schematic diagram of the fourth optical embodiment according to the embodiment in the present invention.

FIG. **29** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the fourth optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **30** is a schematic diagram of the fifth optical embodiment according to the embodiment in the present invention.

FIG. **31** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the fifth optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **32** is a schematic diagram of the sixth optical embodiment according to the embodiment in the present invention.

FIG. **33** is a curve diagram of the spherical aberration, the astigmatism, and the optical distortion of the sixth optical embodiment illustrated sequentially from the left to the right according to the embodiment in the present invention.

FIG. **34** is a schematic diagram of the optical image capturing module applied to a mobile communication device according to the embodiment in the present invention.

FIG. **35** is a schematic diagram of the optical image capturing module applied to a mobile information device according to the embodiment in the present invention.

FIG. **36** is a schematic diagram of the optical image capturing module applied to a smart watch according to the embodiment in the present invention.

FIG. **37** is a schematic diagram of the optical image capturing module applied to a smart hat according to the embodiment in the present invention.

FIG. **38** is a schematic diagram of the optical image capturing module applied to a safety monitoring device according to the embodiment in the present invention.

FIG. **39** is a schematic diagram of the optical image capturing module applied to a vehicle imaging device according to the embodiment in the present invention.

FIG. **40** is a schematic diagram of the optical image capturing module applied to a unmanned aircraft device according to the embodiment in the present invention.

FIG. **41** is a schematic diagram of the optical image capturing module applied to an extreme sport imaging device according to the embodiment in the present invention.

FIG. **42** is a flow chart according to the embodiment in the present invention.

FIG. **43** is a seventeenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **44** is an eighteenth schematic implementation diagram according to the embodiment in the present invention.

FIG. **45** is an nineteenth schematic implementation diagram according to the embodiment in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

To facilitate the review of the technique features, contents, advantages, and achievable effects of the present invention, the embodiments together with the attached drawings are described below in detail. However, the drawings are used for the purpose of indicating and supporting the specification, which may not depict the real proportion of elements and precise configuration in the implementation of the present invention. Therefore, the depicted proportion and configuration of the attached drawings should not be interpreted to limit the scope of implementation of the present invention.

The embodiment of the optical image capturing module and the method thereof in the present invention are explained with reference to the related figures. For ease of understanding, the same elements in the following embodiment are explained in accordance with the same symbols.

As shown in FIG. **1** to FIG. **4**, FIG. **7**, and FIG. **8** to FIG. **11**, the optical image capturing module in the present invention may include a circuit assembly **100** and a lens assembly **200**. The lens assembly **100** includes a circuit substrate **120**, a plurality of image sensor elements **140**, a plurality of signal transmission elements **160**, and a multi-lens frame **180**. The lens assembly **200** may include a plurality of lens bases **220** and a plurality of fixed-focus lens assemblies **230**.

Specifically, the circuit substrate **120** may include a plurality of circuit contacts **122**. Each of the image sensor elements **140** may include a first surface **142** and a second surface **144**. As shown in FIG. **3**, LS is a maximum value of a minimum side length of an outer periphery of the image sensor elements **140** perpendicular to the optical axis on the surface. The first surface **142** may be connected to the circuit substrate **120**. The second surface **144** may have a sensing surface **1441**. The plurality of signal transmission elements **160** may be electrically connected between the plurality of circuit contacts **122** on the circuit substrate **120** and each of the plurality of image contacts **140** of each of the image sensor elements **146**. In an embodiment, the signal transmission elements **160** may be made from the material selected from gold wires, flexible circuit boards, spring needles, solder balls, bumps, or the combination thereof.

In addition, the multi-lens frame **180** may be manufactured integrally, in a molding approach for instance, be covered on the circuit substrate **120** and the image sensor elements **140**. A part of the plurality of signal transmission elements **160** may be embedded in the multi-lens frame **180**, whereas the other part of the signal transmission elements **160** may be surrounded by the multi-lens frame **180**. The positions corresponding to the sensing surface **1441** of the plurality of image sensor elements **140** may have a plurality of light channels **182**. Therefore, embedding a part of the signal transmission elements **160** in the multi-lens frame **180** may prevent the signal transmission elements **160** from being deformed in the manufacturing process. Such a situation may cause many problems like short circuits. Thus, the overall size of the optical module may be minimized.

The plurality of lens bases **220** may be made of opaque material and have an accommodating hole **2201** passing through two ends of the lens bases **220** so that the lens bases **220** become hollow, and the lens bases **220** may be disposed on the multi-lens frame **180** so that the accommodating hole **2201** is connected to the light channel **182**. In addition, in an embodiment, the reflectance of the multi-lens frame **180** is less than 5% in a light wavelength range of 435-660 nm. Therefore, the effect of the stray light caused by reflection or other factors on the image sensor elements **140** may be prevented after light enters the light channel **182**.

Furthermore, in an embodiment, materials of the multi-lens frame include any one of metal, conducting material, and alloy, or any combination thereof, thus increasing the heat dissipation efficiency or decreasing static electricity. This allows the image sensor elements **140** and the fixed-focus lens assembly **230** to function more efficiently.

Furthermore, in an embodiment, materials of the multi-lens frame **180** include any one of thermoplastic resin, plastic used for industries, or any combination thereof, thus having the advantages of easy processing and light weight. This allows the image sensor elements **140** and the fixed-focus lens assembly **230** to function more efficiently.

In an embodiment, as shown in FIG. **2**, the multi-lens frame **180** may include a plurality of camera lens holders **181** having the light channel **182** and a central axis. The distance between the central axes of adjacent camera lens holders is a value between 2 mm and 200 mm. Therefore, the distance between the camera lens holders **181** may be adjusted within this range.

In an embodiment, as shown in FIG. **12** to FIG. **16**, the multi-lens frame **180** may be manufactured in a molding approach. In this approach, the mold may be divided into a mold-fixed side **503** and a mold-moving side **502**. When the mold-moving side **502** is covered on the mold-fixed side **503**, the material may be filled in the mold from the injection port **501** to form the multi-lens frame **180**. Moreover, a part of the signal transmission elements **160** may be embedded in the multi-lens frame **180** to make the signal transmission elements **160** fixed in position when the multi-lens frame **180** is formed, which may minimize the overall size of the optical module.

Therefore, in an embodiment as shown in FIG. **15**, the multi-lens frame **180** surrounding the signal transmission elements **160** may have an outer surface **184**, a first inner surface **186**, and second inner surface **188**. The outer surface **184** extends from an edge of the circuit substrate **120**, and has a tilted angle α with a central normal line of the sensing surface **1441**. α is a value between 1° to 30°. The first inner surface **186** is an inner surface of the light channel **182**. The first inner surface **186** has a tilted angle β with a central normal line of the sensing surface **1441**. β is a value between 1° to 45°. The second inner surface **188** extends from the top surface of the circuit substrate **120** to the light channel **182**, and has a tilted angle γ with a central normal line of the sensing surface **1441**. γ is a value between 1° to 3°. With the positions of the tilted angle α, β, and γ, inferior quality of the multi-lens frame **180** may be prevented when the mold-moving side **502** is detached from the mold-fixed side **503**, thus minimizing the chances for the situations like poor release features and molding flash.

Specifically, in an embodiment, as shown in FIG. **12** to FIG. **13**, the multi-lens frame **180** may initially be formed partially, as in FIG. **12**. After the signal transmission elements **160** are embedded in the multi-lens frame **180**, the multi-lens frame **180** may thus be formed integrally. This makes the signal transmission elements **160** fixed in position when the multi-lens frame **180** is formed, which may minimize the overall size of the optical module.

As shown in FIG. **13**, for the multi-lens frame **180** surrounding the signal transmission elements **160**, under the condition that the multi-lens frame **180** is formed partially to embed a part of the signal transmission elements **160**, the finally-formed multi-lens frame **180** may have an outer surface **184**, a first inner surface **186**, and second inner surface **188**. The outer surface **184** extends from an edge of the circuit substrate **120**, and has a tilted angle α with a central normal line of the sensing surface **1441**. α is a value between 1° to 30°. The first inner surface **186** is an inner surface of the light channel **182**. The first inner surface **186** has a tilted angle β with a central normal line of the sensing surface **1441**. β is a value between 1° to 45°. The second inner surface **188** extends from the image sensor elements **140** to the light channel **182**, and has a tilted angle γ with a central normal line of the sensing surface **1441**. γ is a value between 1° to 3°. With the positions of the tilted angle α, β, and γ, inferior quality of the multi-lens frame **180** may be prevented when the mold-moving side **502** is detached from the mold-fixed side **503**, thus minimizing the chances for the situations like poor release features and molding flash.

In another embodiment, as shown in FIG. **15** and FIG. **16**, under the condition that the multi-lens frame **180** is formed directly to embed a part of the signal transmission elements **160**, the finally-formed multi-lens frame **180** may have an outer surface **184**, a first inner surface **186**, and a second inner surface **188**. The outer surface **184** extends from an edge of the circuit substrate **120**, and has a tilted angle α

with a central normal line of the sensing surface **1441**. α is a value between 1° to 30°. The first inner surface **186** is an inner surface of the light channel **182**. The first inner surface **186** has a tilted angle β with a central normal line of the sensing surface **1441**. β is a value between 1° to 45°. With the positions of the tilted angle α and β, inferior quality of the multi-lens frame **180** may be prevented when the mold-moving side **502** is detached from the mold-fixed side **503**, thus minimizing the chances for the situations like poor release features and molding flash.

In addition, in another embodiment, the multi-lens frame **180** may also be manufactured integrally by 3D printing. The tilted angle α, β, and γ may be formed according to demands. For instance, the tilted angle α, β, and γ may be used to improve structural intensity and minimize stray light, etc.

Each of the fixed-focus lens assemblies **230** may have at least two lenses **2401** with refractive power, be disposed on the lens base **220**, and be positioned in the accommodating hole **2201**. The image planes of each of the fixed-focus lens assemblies **230** may be disposed on the sensing surface **1441**. An optical axis of each of the fixed-focus lens assemblies **230** may overlap the central normal line of the sensing surface **1441** in such a way that light is able to pass through each of the fixed-focus lens assemblies **230** in the accommodating hole **2201**, pass through the light channel **182**, and be emitted to the sensing surface **1441** to ensure image quality. In addition, PhiB denotes the maximum diameter of the image side surface of the lens nearest to the image plane in each of the fixed-focus lens assemblies **230**. PhiA, also called the optical exit pupil, denotes a maximum effective diameter of the image side surface of the lens nearest to the image plane (image space) in each of the fixed-focus lens assemblies **230**.

The fixed-focus lens assembly **230** further satisfies the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0 \leq 2(ARE/HEP) \leq 2.0;$$

Specifically, f is the focal length of the fixed-focus lens assembly **230**. HEP is the entrance pupil diameter of the fixed-focus lens assembly **230**. HAF is the half maximum angle of view of the fixed-focus lens assembly **230**. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly **230**. PhiA is the maximum effective diameter of the fixed-focus lens assembly **230** nearest to a lens surface of the image plane. ARE is the arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly **230**, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

In an embodiment, as shown in FIG. **3** to FIG. **6**, the lens base **220** may include the lens barrel **222** and lens holder **224**. The lens barrel **222** may have an upper hole **2221** which passes through two ends of the lens barrel **222**, and the lens holder **224** may have a lower hole **2241** which passes through two ends of the lens holder **224** with a predetermined wall thickness TH1. PhiD denotes the maximum value of a minimum side length of an outer periphery of the lens holder **224** perpendicular to the optical axis on the surface.

The lens barrel **222** may be disposed in the lens holder **224** and be positioned in the lower hole **2241** with a predetermined wall thickness TH2. PhiC is defined as the maximum diameter of the outer periphery perpendicular to the optical axis on the surface. This allows the upper hole **2221** and the lower hole **2241** to be connected to constitute the accommodating hole **2201**. The lens holder **224** may be fixed on the multi-lens frame **180** in such a way that the image sensor element **140** is positioned in the lower hole **2241**. The upper hole **2221** of the lens barrel **222** faces the sensing surface **1441** of the image sensor element **140**. The fixed-focus lens assembly **230** are disposed in the lens barrel **222** and is positioned in the upper hole **2221**. PhiD is the maximum value of a minimum side length of an outer periphery of the lens holder **224** perpendicular to the optical axis of fixed-focus lens assembly **230**.

In an embodiment, the optical image capturing module **10** may further include at least one data transmission line **400** electrically connected to the circuit substrate **120** and transmits a plurality of sensing signals generated from each of the plurality of 140 image sensor elements.

Furthermore, as shown in FIG. **8** and FIG. **10**, a single data transmission line **400** may be used to transmit a plurality of sensing signals generated from each of the plurality of image sensor elements **140** of a dual lens, three lenses, array, or multi-lens optical image capturing module **10**.

In another embodiment, as shown in FIG. **9** and FIG. **11**, a plurality of single data transmission lines **400** may separately be disposed to transmit a plurality of sensing signals generated from each of the plurality of image sensor elements **140** of a dual lens, three lenses, array, or multi-lens optical image capturing module **10**.

In addition, in an embodiment, the plurality of image sensor elements **140** may sense a plurality of color images. Therefore, the optical image capturing module **10** in the present invention has the efficacy of filming colorful images and colorful videos. In another embodiment, at least one of the image sensor elements **140** may sense a plurality of black-and-white images and at least one of the image sensor elements **140** may sense a plurality of color images. Therefore, the optical image capturing module **10** in the present invention may sense a plurality of black-and-white images together with the image sensor elements **140** of the plurality of color images to acquire more image details and sensitivity needed for filming target objects. This allows the generated images or videos to have higher quality.

In an embodiment, as shown in FIG. **3** to FIG. **7** and FIG. **17** to FIG. **21**, the optical image capturing module **10** may further include IR-cut filters **300**. The IR-cut filter **300** may be disposed in the lens base **220**, located in the accommodating hole **2201**, and positioned on the image sensor element **140** to filter out infrared ray. This may prevent image quality of the sensing surface **1441** of the image sensor elements **140** from being affected by the infrared ray. In an embodiment, as shown in FIG. **5**, the IR-cut filter **300** may be disposed on the lens barrel **222** and the lens holder **224** and be positioned on the image sensor element **140**.

In an embodiment, as shown in FIG. **6**, the lens base **220** may include a filter holder **226**. The filter holder **226** may have a filter hole **2261**. The IR-cut filter **300** may be disposed in the filter holder **226** and be positioned in the filter hole **2261**, and the filter holder **226** may correspond to positions of the plurality of light channels **182** and be disposed on the multi-lens frame **180** in such a way that the IR-cut filter **300** is positioned on the image sensor element **40** to filter out the infrared ray. This may prevent image quality of the sensing surface **1441** of the image sensor elements **140** from being affected by the infrared ray.

Therefore, under the condition that the lens base **220** includes a filter holder **226**, the lens barrel **222** has an upper hole **2221** which passes through two ends of the lens barrel **222**, and the lens holder **224** has a lower hole **2241** which passes through two ends of the lens holder **224**, the lens barrel **222** may be disposed in the lens holder **224** and be positioned in the lower hole **2241**. The lens holder **224** may be fixed on the filter holder **226**. The lower hole **2241**, the upper hole **2221**, and the filter hole **2261** are connected to constitute the accommodating hole **2201** in such a way that the image sensor element **140** is positioned in the filter hole **2261**. The upper hole **2221** of the lens barrel **222** may face the sensing surface **1441** of the image sensor element **140**. The fixed-focus lens assembly **230** may be disposed may be disposed in the lens barrel **222** and positioned in the upper hole **2221** in such a way that the IR-cut filter **300** is positioned on the image sensor elements **140** to filter out the infrared ray entering the fixed-focus lens assembly **230**. This may prevent image quality of the sensing surface **1441** of the image sensor elements **140** from being affected by the infrared ray.

In an embodiment, the present invention may be duel lenses of the optical image capturing module **10**. Therefore, the plurality of fixed-focus lens assemblies **230** may include a first lens assembly and a second lens assembly. A field of view (FOV) of the second lens assembly may be larger than that of the first lens assembly **2411**, and the field of view (FOV) of the second lens assembly may be larger than 46°. Therefore, the second lens assembly may be a wide-angle lens assembly.

Specifically, the plurality of fixed-focus lens assemblies **230** may include a first lens assembly and a second lens assembly, and the focal length of the first lens assembly is larger than that of the second lens assembly. If a traditional photo in the size of 35 mm (The field of view is 46°) is regarded as a basis, the focal length may be 50 mm. When the focal length of the first lens assembly is larger than 50 mm, the first lens assembly may be a long focal lens assembly. In a preferred embodiment, a CMOS sensor (with a field of view of 70°) with the diagonal of 4.6 mm is regarded as a basis, the focal length is approximately 3.28 mm. When the focal length of the first lens assembly is larger than 3.28 mm, the first lens assembly may be a long focal lens assembly.

In an embodiment, the present invention may be a three-lens optical image capturing module **10**. Thus, the optical image capturing module **10** may have at least three fixed-focus lens assemblies **230** which may include a first lens assembly, a second lens assembly, and a third lens assembly. The plurality of fixed-focus assemblies **230** may include the first lens assembly, the second lens assembly, and the third lens assembly. The field of view (FOV) of the second lens assembly may be larger than that of the first lens assembly, and the field of view (FOV) of the second lens assembly may be larger than 46°. Each of plurality of the image sensor elements **140** correspondingly receiving lights from the first lens assembly **2411** and the second lens assembly **2421** senses a plurality of color images. The image sensor elements **140** corresponding to the third lens assembly may sense a plurality of color images or a plurality of black and white images according to requirements.

In an embodiment, the present invention may be a three-lens optical image capturing module **10**. Thus, the optical image capturing module **10** may have at least three fixed-focus lens assemblies **230** which may include a first lens assembly, a second lens assembly, and a third lens assembly. The plurality of fixed-focus assemblies **230** may include the first lens assembly, the second lens assembly, and the third lens assembly. Moreover, the focal length of the first lens assembly is larger than that of the second lens assembly. Each of plurality of the image sensor elements **140** correspondingly receiving lights from the first lens assembly and the second lens assembly senses a plurality of color images. The image sensor elements **140** corresponding to the third lens assembly may sense a plurality of color images or a plurality of black and white images according to requirements.

In an embodiment, the optical image capturing module **10** further satisfies the following conditions:

$0<(TH1+TH2)/HOI\leq 0.95$; specifically, TH1 is the maximum thickness of the lens holder **224**; TH2 is the minimum thickness **222** of the lens barrel; HOI is the maximum image height perpendicular to the optical axis on the image plane.

In an embodiment, the optical image capturing module **10** further satisfies the following conditions:

$0\text{ mm}<TH1+TH2\leq 1.5\text{ mm}$; specifically, TH1 is the maximum thickness of the lens holder **224**; TH2 is the minimum thickness **222** of the lens barrel.

In an embodiment, the optical image capturing module **10** further satisfies the following conditions:

$0.9\leq ARS/EHD\leq 2.0$. Specifically, ARS is the arc length along an outline of the lens **2401** surface, starting from an intersection point of any lens **2401** surface of any lens **2401** and the optical axis in the fixed-focus lens assembly **230**, and ending at a maximum effective half diameter point of the lens **2401** surface; EHD is the maximum effective half diameter of any surface of any lens **2401** in the fixed-focus lens assembly **230**.

In an embodiment, the optical image capturing module **10** further satisfies the following conditions:

$PLTA\leq 100\ \mu m$; $PSTA\leq 100\ \mu m$; $NLTA\leq 100\ \mu m$ and $NSTA\leq 100\ \mu m$; $SLTA\leq 100\ \mu m$; $SSTA\leq 100\ \mu m$. Specifically, HOI is first defined as the maximum image height perpendicular to the optical axis on the image plane; PLTA is the lateral aberration of the longest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module **10** passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; PSTA is the lateral aberration of the shortest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module **10** passing through a margin of an entrance pupil and incident at the image plane by 0.7 HO; NLTA is the lateral aberration of the longest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module **10** passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; NSTA is the lateral aberration of the shortest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module **10** passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; SLTA is the lateral aberration of the longest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module **10** passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI; SSTA is the lateral aberration of the shortest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module **10** passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI.

In addition to the structural embodiment as mentioned above, an optical embodiment related to the fixed-focus lens assembly **230** is to be described as follows. The optical image capturing module in the present invention may be designed using three operational wavelengths, namely 486.1 nm, 587.5 nm, 656.2 nm. Wherein, 587.5 nm is the main reference wavelength for the technical features. The optical image capturing module in the present invention may be designed using five operational wavelengths, namely 470 nm, 587.5 nm, 656.2 nm. Wherein, 587.5 nm is the main reference wavelength for the technical features.

PPR is the ratio of the focal length f of the optical image capturing module **10** to a focal length fp of each of lenses with positive refractive power. NPR is the ratio of the focal length f of the optical image capturing module **10** to the focal length fn of each of lenses with negative refractive power. The sum of the PPR of all the lenses with positive refractive power is ΣPPR. The sum of the NPR of all the leases with negative refractive power is ΣNPR. Controlling the total refractive power and total length of the optical image capturing module **10** may be achieved when the following conditions are satisfied: $0.5 \leq \Sigma PPR/|\Sigma NPR \leq 15$. Preferably, the following conditions may be satisfied: $1 \leq \Sigma PPR/|\Sigma NPR|3.0$.

In addition, HOI is defined as half a diagonal of a sensing field of the image sensor elements **140** (i.e., the imaging height or the maximum imaging height of the optical image capturing module **10**). HOS is a distance on the optical axis from an object side surface of the first lens **2411** to the image plane, which satisfies the following conditions: $HOS/HOI \leq 50$; and $0.5 \leq HOS/f \leq 150$. Preferably, the following conditions are satisfied: $1 \leq HOS/HOI \leq 40$; $1 \leq HOS/f \leq 140$. Therefore, the optical image capturing module **10** may be maintained in miniaturization so that the module may be equipped on thin and portable electronic products.

In addition, in an embodiment, at least one aperture may be disposed in the optical image capturing module **10** in the present invention to reduce stray light and enhance imaging quality.

Specifically, the disposition of the aperture may be a front aperture or a middle aperture in the optical image capturing module **10** in the present invention. Wherein, the front aperture is the aperture disposed between the shot object and the first lens **2411**. The front aperture is the aperture disposed between the first lens **2411** and the image plane. If the aperture is the front aperture, a longer distance may be created between the exit pupil and the image plane in the optical image capturing module **10** so that more optical elements may be accommodated and the efficiency of image sensor elements receiving images may be increased. If the aperture is the middle aperture, the field of view of the system may be expended in such a way that the optical image capturing module has the advantages of a wide-angle lens. InS is defined as the distance from the aforementioned aperture to the image plane, which satisfies the following condition: $0.1 \leq InS/HOS \leq 1.1$. Therefore, the features of the optical image capturing module **10** maintained in miniaturization and having wide-angle may be attended simultaneously.

In the optical image capturing module **10** in the present invention, InTL is a distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the sixth lens **2461**. ΣTP is the sum of the thicknesses of all the lenses with refractive power on the optical axis. The following conditions are satisfied: $0.1 \leq \Sigma TP/InTL \leq 0.9$. Therefore, the contrast ratio of system imaging and the yield rate of lens manufacturing may be attended simultaneously. Moreover, an appropriate back focal length is provided to accommodate other elements.

R1 is the curvature radius of the object side surface of the first lens **2411**. R2 is the curvature radius of the image side surface of the first lens **2411**. The following condition is satisfied: $0.001 \leq |R1/R2| \leq 25$. Therefore, the first lens **2411** is e with appropriate intensity of positive refractive power to prevent the spherical aberration from increasing too fast. Preferably, the following condition is satisfied: $0.01 \leq |R1/R2| < 12$.

R11 is the curvature radius of the object side surface of the sixth lens **2461**. R12 is the curvature radius of the image side surface of the sixth lens **2461**. This following condition is satisfied: $-7 < (R11-R12)/(R11+R12) < 50$. Therefore, it is advantageous to correct the astigmatism generated by the optical image capturing module **10**.

IN12 is the distance between the first lens **2411** and the second lens **2421** on the optical axis. The following condition is satisfied: $IN12/f \leq 60$. Therefore, it is beneficial to improve the chromatic aberration of the lenses so as to enhance the performance.

IN56 is the distance between the fifth lens **2451** and the sixth lens **2461** on the optical axis. The following condition is satisfied: $IN56/f \leq 3.0$. Therefore, it is beneficial to improve the chromatic aberration of the lens assemblies so as to enhance the performance.

TP1 and TP2 are respectively the thicknesses of the first lens **2411** and the second lens **2421** on the optical axis. The following condition is satisfied: $0.1 \leq (TP1+IN12)/TP2 \leq 10$. Therefore, it is beneficial to control the sensitivity produced by the optical image capturing module so as to enhance the performance.

TP5 and TP6 are respectively the thicknesses of the fifth lens **2451** and the sixth lens **2461** on the optical axis. The following condition is satisfied: $0.1 \leq (TP6+IN56)/TP5 \leq 15$. Therefore, it is beneficial to control the sensitivity produced by the optical image capturing module so as to enhance the performance.

TP2, TP3, and TP4 are respectively the thicknesses of the second lens **2421**, the third lens **2431**, and the fourth lens **2441** on the optical axis. IN23 is the distance between the second lens **2421** and the third lens **2431** on the optical axis. IN45 is the distance between the third lens **2431** and the fourth lens **2441** on the optical axis. InTL is the distance from an object side surface of the first lens **2411** to an image side surface of the sixth lens **2461**. The following condition is satisfied: $0.1 \leq TP4/(IN34+TP4+IN45) < 1$. Therefore, it is beneficial to slightly correct the aberration generated by the incident light advancing in the process layer upon layer so as to decrease the overall height of the system.

In the optical image capturing module **10**, HVT61 is the distance perpendicular to the optical axis between a critical point C61 on an object side surface of the sixth lens **2461** and the optical axis. HVT62 is the distance perpendicular to the optical axis between a critical point C62 on an image side surface of the sixth lens **2461** and the optical axis. SGC61 is a distance parallel to the optical axis from an axial point on the object side surface of the sixth lens to the critical point C61. SGC62 is the distance parallel to the optical axis from an axial point on the image side surface of the sixth lens to the critical point C62. The following conditions may be satisfied: $0\ mm \leq HVT61 \leq 3\ mm$; $0\ mm < HVT62 \leq 6\ mm$; $0 \leq HVT61/HVT62$; $0\ mm \leq |SGC61| \leq 0.5\ mm$; 0

mm<|SGC62|≤0.2 mm; and 0<|SGC62|/(|SGC62|+TP6)≤0.9. Therefore, it may be effective to correct the aberration of the off-axis view field.

The optical image capturing module **10** in the present disclosure satisfies the following condition: 0.2≤HVT62/HOI≤0.9. Preferably, the following condition may be satisfied: 0.3≤HVT62/HOI≤0.8. Therefore, it is beneficial to correct the aberration of surrounding view field for the optical image capturing module.

The optical image capturing module **10** in the present disclosure satisfies the following condition: 0≤HVT62/HOS≤0.5. Preferably, the following condition may be satisfied: 0.2≤HVT62/HOS≤0.45. Hereby, it is beneficial to correct the aberration of surrounding view field for the optical image capturing module.

In the optical image capturing module **10** in the present disclosure, SGI611 denotes a distance parallel to an optical axis from an inflection point on the object side surface of the sixth lens **2461** which is nearest to the optical axis to an axial point on the object side surface of the sixth lens **2461**. SGI621 denotes a distance parallel to an optical axis from an inflection point on the image side surface of the sixth lens **2461** which is nearest to the optical axis to an axial point on the image side surface of the sixth lens **2461**. The following condition are satisfied: 0<SGI611/(SGI61+TP6)≤0.9; 0<SGI621/(SGI621+TP6)≤0.9. Preferably, the following conditions may be satisfied: 0.1≤SGI611/(SGI611+TP6)≤0.6; 0.1≤SGI621/(SGI621+TP6)≤0.6.

SGI612 denotes a distance parallel to the optical axis from the inflection point on the object side surface of the sixth lens **2461** which is the second nearest to the optical axis to an axial point on the object side surface of the sixth lens **2461**. SGI622 denotes a distance parallel to an optical axis from an inflection point on the image side surface of the sixth lens **2461** which is the second nearest to the optical axis to an axial point on the image side surface of the sixth lens **2461**. The following conditions are satisfied: 0<SGI612/(SGI612+TP6) 0.9; 0<SGI622 (SGI622+TP6)≤0.9. Preferably, the following conditions may be satisfied: 0.1≤SGI612/(SGI612+TP6)≤0.6; 0.1≤SGI622/(SGI622+TP6)≤0.6.

HIF611 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface of the sixth lens **2461** which is the nearest to the optical axis and the optical axis. HIF621 denotes the distance perpendicular to the optical axis between an axial point on the image side surface of the sixth lens **2461** and an inflection point on the image side surface of the sixth lens **2461** which is the nearest to the optical axis. The following conditions are satisfied: 0.001 mm≤|HIF611|≤5 mm; 0.001 mm≤|HIF621|≤5 mm. Preferably, the following conditions may be satisfied: 0.1 mm≤|HIF611|≤3.5 mm; 1.5 mm≤|HIF621|≤3.5 mm.

HIF612 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface of the sixth lens **2461** which is the second nearest to the optical axis and the optical axis. HIF622 denotes the distance perpendicular to the optical axis between an axial point on the image side surface of the sixth lens **2461** and an inflection point on the image side surface of the sixth lens which is the second nearest to the optical axis. The following conditions are satisfied: 0.001 mm≤|HIF612|≤5 mm; 0.001 mm≤|HIF622|≤0.5 mm. Preferably, the following conditions may be satisfied: 0.1 mm≤|HIF622|≤3.5 mm; 0.1 mm≤|HIF612|≤3.5 mm.

HIF613 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface of the sixth lens **2461** which is the third nearest to the optical axis and the optical axis. HIF623 denotes the distance perpendicular to the optical axis between an axial point on the image side surface of the sixth lens **2461** and an inflection point on the image side surface of the sixth lens **2461** which is the third nearest to the optical axis. The following conditions are satisfied: 0.001 mm≤|HIF613|≤5 mm; 0.001 mm≤|HIF623|≤5 mm. Preferably, the following conditions may be satisfied: 0.1 mm≤|HIF623|≤0.3.5 mm; 0.1 mm≤|HIF613|≤3.5 mm.

HIF614 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface of the sixth lens **2461** which is the fourth nearest to the optical axis and the optical axis. HIF624 denotes the distance perpendicular to the optical axis between an axial point on the image side surface of the sixth lens **2461** and an inflection point on the image side surface of the sixth lens **2461** which is the fourth nearest to the optical axis. The following conditions are satisfied: 0.001 mm≤|HIF614|≤5 mm; 0.001 mm≤|HIF624|≤5 mm. Preferably, the following relations may be satisfied: 0.1 mm≤|HIF624|≤3.5 mm and 0.1 mm≤|HIF614|≤3.5 mm.

In the optical image capturing module in the present disclosure, (TH1+TH2)/HOI satisfies the following condition: 0<(TH1+TH2)/HOI≤0.95, or 0<(TH1+TH2)/HOI≤0.5 preferably. (TH1+TH2)/HOS satisfies the following condition: 0<(TH1+TH2)/HOS≤0.95, or 0<(TH1+TH2)/HOS≤0.5 preferably. 2*(TH1+TH2)/PhiA satisfies the following condition: 0<2*(TH1+TH2)/PhiA≤0.95, or 0<2*(TH1+TH2)/PhiA≤0.5 preferably.

In an embodiment of the optical image capturing module **10** in the present disclosure, interchangeably arranging the lenses with a high dispersion coefficient and a low dispersion coefficient is beneficial to correcting the chromatic aberration of optical imaging module.

The equation for the aspheric surface as mentioned above is:

$$z=ch2/[1+[1(k+1)c2h2]0.5]+A4h4+A6h6+A8h8+A10h10+A12h12+A14h14+A16h16+A18h18+A20h20+\ldots \quad (1)$$

Wherein, z is a position value of the position along the optical axis at the height h where the surface apex is regarded as a reference; k is the conic coefficient; c is the reciprocal of curvature radius; and A4, A6, A8, A10, A12, A14, A16, A18, and A20 are high order aspheric coefficients.

In the optical image capturing module provided by the present disclosure, the material of the lens may be made of glass or plastic. Using plastic as the material for producing the lens may effectively reduce the cost of manufacturing. In addition, using glass as the material for producing the lens may control the heat effect and increase the designed space configured by the refractive power of the optical image capturing module. Moreover, the object side surface and the image side surface from the first lens **2411** to the sixth lens **2471** may be aspheric, which may obtain more control variables. Apart from eliminating the aberration, the number of lenses used may be reduced compared with that of traditional lenses used made by glass. Thus, the total height of the optical image capturing module may be reduced effectively.

Furthermore, in the optical image capturing module **10** provided by the present disclosure, when the surface of the lens is a convex surface, the surface of the lens adjacent to the optical axis is convex in principle. When the surface of the lens is a concave surface, the surface of the lens adjacent to the optical axis is concave in principle.

In the optical image capturing module in the present application, at least one of the first lens **2411**, the second lens **2421**, the third lens **2431**, the fourth lens **2441**, the fifth lens **2451**, and sixth lens **2461** may further be designed as a light filtration element with a wavelength of less than 500 nm depending on requirements. The light filtration element may be realized by coating at least one surface of the specific lens with the filter function, or may be realized by the lens itself having the material capable of filtering short wavelength.

The image plane of the optical image capturing module **10** in the present application may be a plane or a curved surface depending requirements. When the image plane is a curved surface such as a spherical surface with a curvature radius, the incident angle necessary for focusing light on the image plane may be reduced. Hence, it not only contributes to shortening the length (TTL) of the optical image capturing module, but also promotes the relative illuminance.

The First Optical Embodiment

As shown in FIG. **20**, the fixed-focus lens assembly **230** may include six lenses with refractive power, which are a first lens **2411**, a second lens **2421**, a third lens **2431**, a four lens **2441**, a fifth lens **2451**, and a sixth lens **2461** sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly **230** satisfies the following condition: 0.1≤InTL/HOS≤0.95. Specifically, HOS is the distance from an object side surface of the first lens **2411** to the imaging surface on an optical axis. InTL is the distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the sixth lens **2461**.

Please refer to FIG. **22** and FIG. **23**. FIG. **22** is a schematic diagram of the optical image capturing module according to the first optical embodiment of the present invention. FIG. **23** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the first optical embodiment of the present invention. As shown in FIG. **22**, the optical image capturing module includes a first lens **2411**, an aperture **250**, a second lens **2421**, a third lens **2431**, a four lens **2441**, a fifth lens **2451**, a sixth lens **2461**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has negative refractive power and is made of a plastic material. The object side surface **24112** thereof is a concave surface and the image side surface **24114** thereof is a concave surface, both of which are aspheric. The object side surface **24112** thereof has two inflection points. ARS11 denotes the arc length of the maximum effective half diameter of the object side surface of the first lens. ARS12 denotes the arc length of the maximum effective half diameter of the image side surface of the first lens. ARE11 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the first lens. ARE12 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the first lens. TP1 is the thickness of the first lens on the optical axis.

SGI111 denotes a distance parallel to the optical axis from the inflection point on the object side surface **24112** of the first lens **2411** which is the nearest to the optical axis to an axial point on the object side surface **24112** of the first lens **2411**. SGI121 denotes a distance parallel to an optical axis from an inflection point on the image side surface **24114** of the first lens **2411** which is the nearest to the optical axis to an axial point on the image side surface **24114** of the first lens **2411**. The following conditions are satisfied: SGI111=−0.0031 mm; |SGI111|/(|SGI111|+TP1)=0.0016.

SGI112 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24112** of the first lens **2411** which is the second nearest to the optical axis to an axial point on the object side surface **24112** of the first lens **2411**. SGI122 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24114** of the first lens **2411** which is the second nearest to the optical axis to an axial point on the image side surface **24114** of the first lens **2411**. The following conditions are satisfied: SGI112=1.3178 mm; |SGI112|/(|SGI112|+TP)=0.4052.

HIF111 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24112** of the first lens **2411** which is the nearest to the optical axis and the optical axis. HIF121 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24114** of the first lens **2411** and an inflection point on the image side surface **24114** of the first lens **2411** which is the nearest to the optical axis. The following conditions are satisfied: HIF111=0.5557 mm; HIF111/HOI=0.1111.

HIF112 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24112** of the first lens **2411** which is the second nearest to the optical axis and the optical axis. HIF122 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24114** of the first lens **2411** and an inflection point on the image side surface **24114** of the first lens **2411** which is the second nearest to the optical axis. The following conditions are satisfied: HIF112=5.3732 mm; HIF112/HOI=1.0746.

The second lens **2421** has positive refractive power and is made of a plastic material. The object side surface **24212** thereof is a convex surface and the image side surface **24214** thereof is a convex surface, both of which are aspheric. The object side surface **24212** thereof has an inflection point. ARS21 denotes the arc length of the maximum effective half diameter of the object side surface of the second lens. ARS22 denotes the arc length of the maximum effective half diameter of the image side surface of the second lens. ARE21 denotes an arc length of half the entrance pupil diameter (HEP) of the object side surface of the second lens. ARE22 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the second lens. TP2 is the thickness of the second lens on the optical axis.

SGI211 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24212** of the second lens **2421** which is the nearest to the optical axis to an axial point on the object side surface **24212** of the second lens **2421**. SGI221 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24214** of the second lens **2421** which is the nearest to the optical axis to an axial point on the image side surface **24214** of the second lens **2421**. The following conditions are satisfied: SGI211=0.1069 mm; |SGI211|/(|SGI211|+TP2)=0.0412; SGI221=0 mm; |SGI221|/(|SGI221|+TP2)=0.

HIF211 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24212** of the second lens **2421** which is the nearest to the optical axis and the optical axis. HIF221 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24214** of the second lens **2421** and an inflection point on the image side surface **24214** of the second lens **2421** which is the nearest to the optical axis. The following conditions are satisfied: HIF211=1.1264 mm; HIF211/HOI=0.2253; HIF221=0 mm; HIF221/HOI=0.

The third lens **2431** has negative refractive power and is made of a plastic material. The object side surface **24312** thereof is a concave surface and the image side surface **24314** thereof is a convex surface, both of which are aspheric. The object side surface **24312** and the image side surface **24314** thereof both have an inflection point. ARS31 denotes the arc length of the maximum effective half diameter of the object side surface of the third lens. ARS32 denotes an arc length of the maximum effective half diameter of the image side surface of the third lens. ARE31 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the third lens. ARE32 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the third lens. TP3 is the thickness of the third lens on the optical axis.

SGI311 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24312** of the third lens **2431** which is the nearest to the optical axis to an axial point on the object side surface **24312** of the third lens **2431**. SGI321 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24314** of the third lens **2431** which is the nearest to the optical axis to an axial point on the image side surface **24314** of the third lens **2431**. The following conditions are satisfied: SGI311=−0.3041 mm; |SGI311|/(|SGI311|+TP3)=0.4445; SGI321=−0.1172 mm; |SGI321|/(|SGI321|+TP3)=0.2357.

HIF311 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24312** of the third lens **2431** which is the nearest to the optical axis and the optical axis. HIF321 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24314** of the third lens **2431** and an inflection point on the image side surface **24314** of the third lens **2431** which is the nearest to the optical axis. The following conditions are satisfied: HIF311=1.5907 mm; HIF311/HOI=0.3181; HIF321=1.3380 mm; HIF321/HOI=0.2676.

The fourth lens **2441** has positive refractive power and is made of a plastic material. The object side surface **24412** thereof is a convex surface and the image side surface **24414** thereof is a concave surface, both of which are aspheric. The object side surface **24412** thereof has two inflection points and the image side surface **24414** thereof has an inflection point. ARS41 denotes the arc length of the maximum effective half diameter of the object side surface of the fourth lens. ARS42 denotes the arc length of the maximum effective half diameter of the image side surface of the fourth lens. ARE41 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the fourth lens. ARE42 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the fourth lens. TP4 is the thickness of the fourth lens on the optical axis.

SGI411 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24412** of the fourth lens **2441** which is the nearest to the optical axis to an axial point on the object side surface **24412** of the fourth lens **2441**. SGI421 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24414** of the fourth lens **2441** which is the nearest to the optical axis to an axial point on the image side surface **24414** of the fourth lens **2441**. The following conditions are satisfied: SGI411=0.0070 mm; |SGI411|/(|SGI411|+TP4)=0.0056; SGI421=0.0006 mm; |SGI421|/(|SGI421|+TP4)=0.0005.

SGI412 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24412** of the fourth lens **2441** which is the second nearest to the optical axis to an axial point on the object side surface **24412** of the fourth lens **2441**. SGI422 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24414** of the fourth lens **2441** which is the second nearest to the optical axis to an axial point on the image side surface **24414** of the fourth lens **2441**. The following conditions are satisfied: SGI412=−0.2078 mm; SGI412|/(|SGI412|+TP4)=0.1439.

HIF411 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24412** of the fourth lens **2441** which is the nearest to the optical axis and the optical axis. HIF421 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24414** of the fourth lens **2441** and an inflection point on the image side surface **24414** of the fourth lens **2441** which is the nearest to the optical axis. The following conditions are satisfied: HIF411=0.4706 mm; HIF411/HOI=0.0941; HIF421=0.1721 mm; HIF421/HOI=0.0344.

HIF412 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24412** of the fourth lens **2441** which is the second nearest to the optical axis and the optical axis. HIF422 denotes the distance perpendicular to the optical axis between an axial point on the image side surface **24414** of the fourth lens **2441** and an inflection point on the image side surface **24414** of the fourth lens **2441** which is the second nearest to the optical axis. The following conditions are satisfied: HIF412=2.0421 mm; HIF412/HOI=0.4084.

The fifth lens **2451** has positive refractive power and is made of a plastic material. The object side surface **24512** thereof is a convex surface and the image side surface **24514** thereof is a convex surface, both of which are aspheric. The object side surface **24512** thereof has two inflection points and the image side surface **24514** thereof has an inflection point. ARS51 denotes the arc length of the maximum effective half diameter of the object side surface of the fifth lens. ARS52 denotes the arc length of the maximum effective half diameter of the image side surface of the fifth lens. ARE51 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the fifth lens. ARE52 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the fifth lens. TP5 is the thickness of the fifth lens on the optical axis.

SGI511 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24512** of the fifth lens **2451** which is the nearest to the optical axis to an axial point on the object side surface **24512** of the fifth lens **2451**. SGI521 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24514** of the fifth lens **2451** which is the nearest to the optical axis to an axial point on the image side surface **24514** of the fifth lens **2451**. The following conditions are satisfied: SGI511=0.00364 mm; |SGI511|/(|SGI511|+TP5)=0.00338; SGI521=−0.63365 mm; |SGI521|/(|SGI521+TP5)=0.37154.

SGI512 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24512** of the fifth lens **2451** which is the second nearest to the optical axis to an axial point on the object side surface **24512** of the fifth lens **2451**. SGI522 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24514** of the fifth lens **2451** which is the second nearest to the optical axis to an axial point on the image side surface **24514** of the fifth lens **2451**. The following conditions are satisfied: SGI512=−0.32032 mm; |SGI512|/(|SGI512|+TP5)=0.23009.

SGI513 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24512** of the fifth lens **2451** which is the third nearest to the optical axis to an axial point on the object side surface **24512** of the fifth lens **2451**. SGI523 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24514** of the fifth lens **2451** which is the third nearest to the optical axis to an axial point on the image side surface **24514** of the fifth lens **2451**. The following conditions are satisfied: SGI513=0 mm; |SGI513|/(|SGI513|+TP5)=0; SGI523=0 mm; |SGI523|/(|SGI523|+TP5)=0.

SGI514 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24512** of the fifth lens **2451** which is the fourth nearest to the optical axis to an axial point on the object side surface **24512** of the fifth lens **2451**. SGI524 denotes a distance parallel to an optical axis from an inflection point on the image side surface **24514** of the fifth lens **2451** which is the fourth nearest to the optical axis to an axial point on the image side surface **24514** of the fifth lens **2451**. The following conditions are satisfied: SGI514=0 mm; |SGI514|/(|SGI514|+TP5)=0; SGI524=0 mm; |SGI524|/(|SGI524|+TP5)=0.

HIF511 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24512** of the fifth lens **2451** which is the nearest to the optical axis and the optical axis. HIF521 denotes the distance perpendicular to the optical axis between the optical axis and an inflection point on the image side surface **24514** of the fifth lens **2451** which is the nearest to the optical axis. The following conditions are satisfied: HIF511=0.28212 mm; HIF511/HOI=0.05642; HIF521=2.13850 mm; HIF521/HOI=0.42770.

HIF512 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24512** of the fifth lens **2451** which is the second nearest to the optical axis and the optical axis. HIF522 denotes the distance perpendicular to the optical axis between the optical axis and an inflection point on the image side surface **24514** of the fifth lens **2451** which is the second nearest to the optical axis. The following conditions are satisfied: HIF512=2.51384 mm; HIF512/HOI=0.50277.

HIF513 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24512** of the fifth lens **2451** which is the third nearest to the optical axis and the optical axis. HIF523 denotes the distance perpendicular to the optical axis between the optical axis and an inflection point on the image side surface **24514** of the fifth lens **2451** which is the third nearest to the optical axis. The following conditions are satisfied: HHIF513=0 mm; HIF513/HOI=0; HIF523=0 mm; HIF523/HOI=0.

HIF514 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24512** of the fifth lens **2451** which is the fourth nearest to the optical axis and the optical axis. HIF524 denotes the distance perpendicular to the optical axis between the optical axis and an inflection point on the image side surface **24514** of the fifth lens **2451** which is the fourth nearest to the optical axis. The following conditions are satisfied: HIF514=0 mm; HIF514/HOI=0; HIF524=0 mm; HIF524/HOI=0.

The sixth lens **2461** has negative refractive power and is made of a plastic material. The object side surface **24612** thereof is a concave surface and the image side surface **24614** thereof is a concave surface. The object side surface **24612** has two inflection points and the image side surface **24614** thereof has an inflection point. Therefore, it may be effective to adjust the angle at which each field of view is incident on the sixth lens to improve the aberration. ARS61 denotes the arc length of the maximum effective half diameter of the object side surface of the sixth lens. ARS62 denotes the arc length of the maximum effective half diameter of the image side surface of the sixth lens. ARE61 denotes the arc length of half the entrance pupil diameter (HEP) of the object side surface of the sixth lens. ARE62 denotes the arc length of half the entrance pupil diameter (HEP) of the image side surface of the sixth lens. TP6 is the thickness of the sixth lens on the optical axis.

SGI611 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24612** of the sixth lens **2461** which is the nearest to the optical axis to an axial point on the object side surface **24612** of the sixth lens **2461**. SGI621 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24614** of the sixth lens **2461** which is the nearest to the optical axis to an axial point on the image side surface **24614** of the sixth lens **2461**. The following conditions are satisfied: SGI611=−0.38558 mm; |SGI611|/(|SGI611|+TP6)=0.27212; SGI621=0.12386 mm; |SGI621|/(|SGI621|+TP6)=0.10722.

SGI612 denotes the distance parallel to the optical axis from the inflection point on the object side surface **24612** of the sixth lens **2461** which is the second nearest to the optical axis to an axial point on the object side surface **24612** of the sixth lens **2461**. SGI621 denotes the distance parallel to an optical axis from an inflection point on the image side surface **24614** of the sixth lens **2461** which is the second nearest to the optical axis to an axial point on the image side surface **24614** of the sixth lens **2461**. The following conditions are satisfied: SGI612=−0.47400 mm; |SGI612|/(|SGI612|+TP6)=0.31488; SGI622=0 mm; |SGI622|/(|SGI622|+TP6)=0.

HIF611 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24612** of the sixth lens **2461** which is the nearest to the optical axis and the optical axis. HIF621 denotes the distance perpendicular to the optical axis between the inflection point on the image side surface **24614** of the sixth lens **2461** which is the nearest to the optical axis and the optical axis. The following conditions are satisfied: HIF611=2.24283 mm; IF611/HOI=0.44857; HIF621=1.07376 mm; HIF621/HOI=0.21475.

HIF612 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24612** of the sixth lens **2461** which is the second nearest to the optical axis and the optical axis. HIF622 denotes the distance perpendicular to the optical axis between the inflection point on the image side surface **24614** of the sixth lens **2461** which is the second nearest to the optical axis and the optical axis. The following conditions are satisfied: HIF611=2.24283 mm; HIF612=2.48895 mm; HIF612/HOI=0.49779.

HIF613 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface **24612** of the sixth lens **2461** which is the third nearest to the optical axis and the optical axis. HIF623 denotes the distance perpendicular to the optical axis between the inflection point on the image side surface **24614** of the sixth lens **2461** which is the third nearest to the optical axis and the optical axis. The following conditions are satisfied: HIF613=0 mm; HIF613/HOI=0; HIF623=0 mm; HIF623/HOI=0.

HIF614 denotes the distance perpendicular to the optical axis between the inflection point on the object side surface

24612 of the sixth lens 2461 which is the fourth nearest to the optical axis and the optical axis. HIF624 denotes the distance perpendicular to the optical axis between the inflection point on the image side surface 24614 of the sixth lens 2461 which is the fourth nearest to the optical axis and the optical axis. The following conditions are satisfied: HIF614=0 mm; HIF614/HOI=0; HIF624=0 mm; HIF624/HOI=0.

The IR-cut filter 300 is made of glass and is disposed between the sixth lens 2461 and the image plane 600, which does not affect the focal length of the optical image capturing module.

In the optical image capturing module of the embodiment, f is the focal length of the lens assembly. HEP is the entrance pupil diameter. HAF is half of the maximum view angle. The detailed parameters are shown as below: f=4.075 mm, f/HEP=1.4, HAF=50.001°, and tan(HAF)=1.1918.

In the optical image capturing module of the embodiment, f1 is the focal length of the first lens assembly 2411. f6 is a focal length of the sixth lens assembly 2461. The following conditions are satisfied: f1=−7.828 mm; |f/f1|=0.52060; f6=−4.886; and |f1|>|f6|.

In the optical image capturing module of the embodiment, the focal lengths of the second lens 2421 to the fifth lens 2451 are 12, f3, f4, and f5, respectively. The following conditions are satisfied: |f2|+|f3|+|f4|+|f5|=95.50815 mm; |f1|+|f6|=12.71352 mm and |f2|+|f3|+|f4|+|f5|>|f1|+|f6|.

PPR is the ratio of the focal length f of the optical image capturing module to a focal length fp of each of lenses with positive refractive power. NPR is the ratio of the focal length f of the optical image capturing module to a focal length fn of each of lenses with negative refractive power. In the optical image capturing module of the embodiment, The sum of the PPR of all lenses with positive refractive power is ΣPPR=f/f2+f/f4+f/f5=1.63290. The sum of the NPR of all lenses with negative refractive power is ΣNPR=|f/f1|+|f/f3|+|f6|=1.51305, and ΣPPR/|ΣNPR|=1.07921. The following conditions are also satisfied: |f/f2|=0.69101; |f/f3|=0.15834; |f/f4|=0.06883; |f/f5|=0.87305; |f/f6|=0.83412.

In the optical image capturing module of the embodiment, InTL is the distance on the optical axis from an object side surface 24112 of the first lens 2411 to an image side surface 24614 of the sixth lens 2461. HOS is the distance on the optical axis from an object side surface 24112 of the first lens 2411 to the image plane 600. InS is a distance from the aperture 250 to the image plane 180. HOI is defined as half the diagonal of the sensing field of the image sensor elements 140. BFL is the distance from the image side surface 24614 of the sixth lens and the image plane 600. The following conditions are satisfied: InTL+BFL=HOS; HOS=19.54120 mm; HOI=5.0 mm; HOS/HOI=3.90824; HOS/f=4.7952; InS=11.685 mm; and InS/HOS=0.59794.

In the optical image capturing module of the embodiment, ΣTP is the sum of the thicknesses of all the lenses with refractive power on the optical axis. The following condition is satisfied: ΣTP=8.13899 mm and ΣTP/InTL=0.52477. Therefore, the contrast ratio of system imaging and the yield rate of lens manufacturing may be attended simultaneously. Moreover, an appropriate back focal length is provided to accommodate other elements.

In the optical image capturing module of the embodiment, R1 is the curvature radius of the object side surface 24112 of the sixth lens 2411. R2 is the curvature radius of the image side surface 24114 of the sixth lens 2411. The following condition is satisfied: |R1/R2|=8.99987. Therefore, the first lens 2411 is equipped with appropriate intensity of positive refractive power to prevent the spherical aberration from increasing too fast.

In the optical image capturing module of the embodiment, R11 is the curvature radius of the object side surface 24612 of the sixth lens 2461. R12 is the curvature radius of the image side surface 24614 of the sixth lens 2461. This following condition is satisfied: (R11−R12)(R11+R12)=1.27780. Therefore, it is advantageous to correct the astigmatism generated by the optical image capturing module.

In the optical image capturing module of the embodiment, ΣPP is the sum of the focal lengths of all lenses with positive refractive power. The following conditions are satisfied: ΣPP=f2+f4+f5=69.770 mm and f5/(f2+f4+f5)=0.067. Therefore, it is beneficial to properly distribute the positive refractive power of a single lens to other positive lenses to suppress the generation of significant aberrations during the traveling of incident light.

In the optical image capturing module of the embodiment, NP is the sum of the focal lengths of all lenses with negative refractive power. The following conditions are satisfied: ΣNP=f1+f3+f6=−38.451 mm and f6/(f1+f3+f6)=0.127. Therefore, it is beneficial to properly distribute the negative refractive power of the sixth lens 2461 to other negative lenses to suppress the generation of significant aberrations during the traveling of incident light.

In the optical image capturing module of the embodiment, IN 12 is the distance between the first lens 2411 and the second lens 2421 on the optical axis. The following condition is satisfied: IN12=6.418 mm; IN12/f=1.57491. Therefore, it is beneficial to improve the chromatic aberration of the lenses so as to enhance the performance.

In the optical image capturing module of the embodiment, IN56 is a distance between the fifth lens 2451 and the sixth lens 2461 on the optical axis. The following condition is satisfied: IN56=0.025 mm; IN56/f=0.00613. Therefore, it is beneficial to improve the chromatic aberration of the lenses so as to enhance the performance.

In the optical image capturing module of the embodiment, TP1 and TP2 are respectively the thicknesses of the first lens 2411 and the second lens 2421 on the optical axis. The following condition is satisfied: TP1=1.934 mm; TP2=2.486 mm; and (TP1+IN12)/TP2=3.36005. Therefore, it is beneficial to control the sensitivity produced by the optical image capturing module so as to enhance the performance.

In the optical image capturing module of the embodiment, TP5 and TP6 are respectively the thicknesses of the fifth lens 2451 and the sixth lens 2461 on the optical axis. IN56 is a distance between the two lenses on the optical axis. The following conditions are satisfied: TP5=1.072 mm; TP6=1.031 mm; (TP6+IN56)/TP5=0.98555. Therefore, it is beneficial to control the sensitivity produced by the optical image capturing module so as to enhance the performance.

In the optical image capturing module of the embodiment, IN34 is a distance between the third lens 2431 and the fourth lens 2441 on the optical axis. The following conditions are satisfied: IN34=0.401 mm; IN45=0.025 mm; and TP4/(IN34+TP4+IN45)=0.74376. Therefore, it is beneficial to slightly correct the aberration generated by the incident light advancing in the process layer upon layer so as to decrease the overall height of the system.

In the optical image capturing module of the embodiment, InRS51 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the object side surface 24512 of the fifth lens 2451. InRS62 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the image side surface **24514** of the fifth lens **2451**. TP5 is the thickness of the fifth lens **2451** on the optical axis. The following condition is satisfied: InRS51=−0.34789 mm; InRS52=−0.88185 mm; |InRS51|/TP5=0.32458 and |InRS52|/TP5=0.82276.

In the optical image capturing module of the embodiment. HVT51 is the distance perpendicular to the optical axis between a critical point on an object side surface **24512** of the fifth lens **2451** and the optical axis. HVT52 is the distance perpendicular to the optical axis between a critical point on an image side surface **24514** of the fifth lens **2451** and the optical axis. The following conditions are satisfied: HVT51=0.515349 mm; HVT52=0 mm.

In the optical image capturing module of the embodiment, InRS61 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the object side surface **24612** of the sixth lens **2461**. InRS62 is the horizontal distance parallel to an optical axis from a maximum effective half diameter position to an axial point on the image side surface **24614** of the sixth lens **2461**. TP6 is the thickness of the sixth lens **2461** on the optical axis. The following conditions are satisfied: InRS61=−0.58390 mm; InRS62=0.41976 mm; |InRS61|/TP6=0.56616 and |InRS62|/TP6=0.40700. Therefore, it is advantageous for the lens to be manufactured and formed so as to maintain minimization.

In the optical image capturing module of the embodiment, HVT61 is the distance perpendicular to the optical axis between a critical point on an object side surface **24612** of the sixth lens **2461** and the optical axis. HVT62 is the distance perpendicular to the optical axis between a critical point on an image side surface **24614** of the sixth lens **2461** and the optical axis. The following conditions are satisfied: HVT61=0 mm; HVT62=0 mm.

In the optical image capturing module of the embodiment, the following conditions are satisfied: HVT51/HOI=0.1031. Therefore, it is beneficial to correct the aberration of surrounding view field for the optical image capturing module.

In the optical image capturing module of the embodiment, the following conditions are satisfied: HVT51/HOS=0.02634. Therefore, it is beneficial to correct the aberration of surrounding view field for the optical image capturing module.

In the optical image capturing module of the embodiment, the second lens **2421**, the third lens **2431**, and the sixth lens **2461** have negative refractive power. A dispersion coefficient of the second lens is NA2. A dispersion coefficient of the third lens is NA3. A dispersion coefficient of the sixth lens is NA6. The following condition is satisfied: NA6/NA2≤1. Therefore, it is beneficial to correct the aberration of the optical image capturing module.

In the optical image capturing module of the embodiment, TDT refers to TV distortion when an image is formed. ODT refers to optical distortion when an image is formed. The following conditions are satisfied: TDT=2.124%; ODT=5.076%.

In the optical image capturing module of the embodiment, LS is 12 mm. PhiA is 2*EHD62=6.726 mm (EHD62; the maximum effective half diameter of the image side **24614** of the sixth lens **2461**). PhiC=PhiA+2*TH2=7.026 mm; PhiD=PhiC+2*(TH1+TH2)=7.426 mm; TH1 is 0.2 mm; TH2 is 0.15 mm; PhiA/PhiD is 0.9057; TH1+TH2 is 0.35 mm; (TH1+TH2)/HOI is 0.035; (TH1+TH2)/HOS is 0.0179; 2*(TH1+TH2)/PhiA is 0.1041; (TH1+TH2)/LS is 0.0292.

Please refer to Table 1 and Table 2 in the following.

TABLE 1

Data of the optical image capturing module of the first optical embodiment
f = 4.075 mm; f/HEP = 1.4; HAF = 50.000 deg

Surface		Curvature Radius	Thickness (mm)	Material
0	Object	Plano	Plano	
1	Lens 1	−40.99625704	1.934	Plastic
2		4.555209289	5.923	
3	Aperture	Plano	0.495	
4	Lens 2	5.333427366	2.486	Plastic
5		−6.781659971	0.502	
6	Lens 3	−5.697794287	0.380	Plastic
7		−8.883957518	0.401	
8	Lens 4	13.19225664	1.236	Plastic
9		21.55681832	0.025	
10	Lens 5	8.987806345	1.072	Plastic
11		−3.158875374	0.025	
12	Lens 6	−29.46491425	1.031	Plastic
13		3.593484273	2.412	
14	IR-cut filter	Plano	0.200	
15		Plano	1.420	
16	Image plane	Plano		

Surface	Refractive index	Dispersion coefficient	Focal length
0			
1	1.515	56.55	−7.828
2			
3			
4	1.544	55.96	5.897
5			
6	1.642	22.46	−25.738
7			
8	1.544	55.96	59.205
9			
10	1.515	56.55	4.668
11			
12	1.642	22.46	−4.886
13			
14	1.517	64.13	
15			
16			

Reference wavelength = 555 nm; Shield position: The clear aperture of the first surface is 5.800 mm. The clear aperture of the third surface is 1.570 mm. The clear aperture of the fifth surface is 1.950 mm.

Table 2. The aspheric surface parameters of the first optical embodiment

TABLE 2

Aspheric Coefficients				
	Surface			
	1	2	4	5
k	4.310876E+01	−4.707622E+00	2.616025E+00	2.445397E+00
A4	7.054243E−03	1.714312E−02	−8.377541E−03	−1.789549E−02
A6	−5.233264E−04	−1.502232E−04	−1.838068E−03	−3.657520E−03

TABLE 2-continued

Aspheric Coefficients				
A8	3.077890E−05	−1.359611E−04	1.233332E−03	−1.131622E−03
A10	−1.260650E−06	2.680747E−05	−2.390895E−03	1.390351E−03
A12	3.319093E−08	−2.017491E−06	1.998555E−03	−4.152857E−04
A14	−5.051600E−10	6.604615E−08	−9.734019E−04	5.487286E−05
A16	3.380000E−12	−1.301630E−09	2.478373E−04	−2.919339E−06

	Surface			
	6	7	8	9
k	5.645686E+00	−2.117147E+01	−5.287220E+00	6.200000E+01
A4	−3.379055E−03	−1.370959E−02	−2.937377E−02	−1.359965E−01
A6	−1.225453E−03	6.250200E−03	2.743532E−03	6.628518E−02
A8	−5.979572E−03	−5.854426E−03	−2.457574E−03	−2.129167E−02
A10	4.556449E−03	4.049451E−03	1.874319E−03	4.396344E−03
A12	−1.177175E−03	−1.314592E−03	−6.013661E−04	−5.542899E−04
A14	1.370522E−04	2.143097E−04	8.792480E−05	3.768879E−05
A16	−5.974015E−06	−1.399894E−05	−4.770527E−06	−1.052467E−06

	Surface			
	10	11	12	13
k	−2.114008E+01	−7.699904E+00	−6.155476E+01	−3.120467E−01
A4	−1.263831E−01	−1.927804E−02	−2.492467E−02	−3.521844E−02
A6	6.965399E−02	2.478376E−03	−1.835360E−03	5.629654E−03
A8	−2.116027E−02	1.438785E−03	3.201343E−03	−5.466925E−04
A10	3.819371E−03	−7.013749E−04	−8.990757E−04	2.231154E−05
A12	−4.040283E−04	1.253214E−04	1.245343E−04	5.548990E−07
A14	2.280473E−05	−9.943196E−06	−8.788363E−06	−9.396920E−08
A16	−5.165452E−07	2.898397E−07	2.494302E−07	2.728360E−09

The values related to arc lengths may be obtained according to table 1 and table 2.

First optical embodiment (Reference wavelength = 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/HEP) %	TP	ARE/TP (%)
11	1.455	1.455	−0.00033	99.98%	1.934	75.23%
12	1.455	1.495	0.03957	102.72%	1.934	77.29%
21	1.455	1.465	0.00940	100.65%	2.486	58.93%
22	1.455	1.495	0.03950	102.71%	2.486	60.14%
31	1.455	1.486	0.03045	102.09%	0.380	391.02%
32	1.455	1.464	0.00830	100.57%	0.380	385.19%
41	1.455	1.458	0.00237	100.16%	1.236	117.95%
42	1.455	1.484	0.02825	101.94%	1.236	120.04%
51	1.455	1.462	0.00672	100.46%	1.072	136.42%
52	1.455	1.499	0.04335	102.98%	1.072	139.83%
61	1.455	1.465	0.00964	100.66%	1.031	142.06%
62	1.455	1.469	0.01374	100.94%	1.031	142.45%
ARS	EHD	ARS value	ARS − EHD	(ARS/EHD) %	TP	ARS/TP (%)
11	5.800	6.141	0.341	105.88%	1.934	317.51%
12	3.299	4.423	1.125	134.10%	1.934	228.70%
21	1.664	1.674	0.010	100.61%	2.486	67.35%
22	1.950	2.119	0.169	108.65%	2.486	85.23%
31	1.980	2.048	0.069	103.47%	0.380	539.05%
32	2.084	2.101	0.017	100.83%	0.380	552.87%
41	2.247	2.287	0.040	101.80%	1.236	185.05%
42	2.530	2.813	0.284	111.22%	1.236	227.63%
51	2.655	2.690	0.035	101.32%	1.072	250.99%
52	2.764	2.930	0.166	106.00%	1.072	273.40%
61	2.816	2.905	0.089	103.16%	1.031	281.64%
62	3.363	3.391	0.029	100.86%	1.031	328.83%

Table 1 is the detailed structure data to the first optical embodiment, wherein the unit of the curvature radius, the thickness, the distance, and the focal length is millimeters (mm). Surfaces 0-16 illustrate the surfaces from the object side to the image side. Table 2 is the aspheric coefficients of the first optical embodiment, wherein k is the conic coefficient in the aspheric surface formula. A1-A20 are aspheric surface coefficients from the first to the twentieth orders for each surface. In addition, the tables for each of the embodiments as follows correspond to the schematic views and the aberration graphs for each of the embodiments. The definitions of data in the tables are the same as those in Table 1 and Table 2 for the first optical embodiment. Therefore, similar description shall not be illustrated again. Furthermore, the definitions of element parameters in each of the embodiments are the same as those in the first optical embodiment.

The Second Optical Embodiment

As shown in FIG. **21**, the fixed-focus lens assembly **230** may include seven lenses **2401** with refractive power, which are a first lens **2411**, a second lens **2421**, a third lens **2431**, a four lens **2441**, a fifth lens **2451**, a sixth lens **2461**, and a seventh lens **2471** sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly **230** satisfies the following condition: $0.1 \leq InTL/HOS \leq 0.95$. Specifically, HOS is the distance on the optical axis from an object side surface of the first lens **2411** to the image plane; InTL is the distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the seventh lens **2471**.

Please refer to FIG. **24** and FIG. **25**. FIG. **24** is a schematic diagram of the optical image capturing module according to the second optical embodiment of the present invention. FIG. **25** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the second optical embodiment of the present invention, As shown in FIG. **24**, the optical image capturing module includes a first lens **2411**, a second lens **2421**, a third lens **2431**, an aperture **250**, a four lens **2441**, a fifth lens **2451**, a sixth lens **2461**, a seventh lens **2471**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has negative refractive power and is made of a glass material. The object side surface **24112** thereof is a convex surface and the image side surface **24114** thereof is a concave surface.

The second lens **2421** has negative refractive power and is made of a glass material. The object side surface thereof **24212** is a concave surface and the image side surface thereof **24214** is a convex surface.

The third lens **2431** has positive refractive power and is made of a glass material. The object side surface **24312** thereof is a convex surface and the image side surface **24314** thereof is a convex surface.

The fourth lens **2441** has positive refractive power and is made of a glass material. The object side surface **24412** thereof is a convex surface and the image side surface **24414** thereof is a convex surface.

The fifth lens **2451** has positive refractive power and is made of a glass material. The object side surface **24512** thereof is a convex surface and the image side surface **24514** thereof is a convex surface.

The sixth lens **2461** has negative refractive power and is made of a glass material. The object side surface **24612** thereof is a concave surface and the image side surface **24614** thereof is a concave surface. Therefore, it may be effective to adjust the angle at which each field of view is incident on the sixth lens **2461** to improve the aberration.

The seventh lens **2471** has positive refractive power and is made of a glass material. The object side surface **24712** thereof is a convex surface and the image side surface **24714** thereof is a convex surface. Therefore, it is advantageous for the lens to reduce the back focal length to maintain minimization.

The IR-cut filter **300** is made of glass and is disposed between the seventh lens **2471** and the image plane **600**, which does not affect the focal length of the optical image capturing module.

Please refer to the following Table 3 and Table 4.

TABLE 3

Data of the optical image capturing module of the second optical embodiment
f = 4.7601 mm; f/HEP = 2.2; HAF = 95.98 deg

Surface		Curvature Radius	Thickness (mm)	Material
0	Object	1E+18	1E+18	
1	Lens 1	47.71478323	4.977	Glass
2		9.527614761	13.737	
3	Lens 2	−14.88061107	5.000	Glass
4		−20.42046946	10.837	
5	Lens 3	182.4762997	5.000	Glass
6		−46.71963608	13.902	
7	Aperture	1E+18	0.850	
8	Lens 4	28.60018103	4.095	Glass
9		−35.08507586	0.323	
10	Lens 5	18.25991342	1.539	Glass
11		−36.99028878	0.546	
12	Lens 6	−18.24574524	5.000	Glass
13		15.33897192	0.215	
14	Lens 7	16.13218937	4.933	Glass
15		−11.24007	8.664	
16	IR-cut filter	1E+18	1.000	BK_7
17		1E+18	1.007	
18	Image plane	1E+18	−0.007	

Surface	Refractive index	Dispersion coefficient	Focal length
0			
1	2.001	29.13	−12.647
2			
3	2.001	29.13	−99.541
4			
5	1.847	23.78	44.046
6			
7			
8	1.834	37.35	19.369
9			
10	1.609	46.44	20.223
11			
12	2.002	19.32	−7.668
13			
14	1.517	64.20	13.620
15			
16	1.517	64.2	
17			
18			

Reference Wavelength = 555 nm

TABLE 4

The aspheric surface parameters of the second optical embodiment
Aspheric Coefficients

Surface	1	2	3	4
k	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A6	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A8	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A10	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A12	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

Surface	5	6	8	9
k	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A6	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A8	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A10	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A12	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

Surface	10	11	12	13
k	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A6	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A8	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A10	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A12	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

Surface	14	15
k	0.000000E+00	0.000000E+00
A4	0.000000E+00	0.000000E+00
A6	0.000000E+00	0.000000E+00
A8	0.000000E+00	0.000000E+00
A10	0.000000E+00	0.000000E+00
A12	0.000000E+00	0.000000E+00

In the second optical embodiment, the aspheric surface formula is presented in the same way in the first optical embodiment. In addition, the definitions of parameters in following tables are the same as those in the first optical embodiment. Therefore, similar description shall not be illustrated again.

The values stated as follows may be deduced according to Table 3 and Table 4.

The second optical embodiment (Primary reference wavelength: 555 nm)					
|f/f1|	|f/f2|	|f/f3|	|f/f4|	|f/f5|	|f/f6|
0.3764	0.0478	0.1081	0.2458	0.2354	0.6208
|f/f7|	ΣPPR	ΣNPR	ΣPPR/ |ΣNPR|	IN12/f	IN67/f
0.3495	1.3510	0.6327	2.1352	2.8858	0.0451
|f1/f2|	|f2/f3|	(TP1 + IN12)/TP2		(TP7 + IN67)/TP6	
0.1271	2.2599	3.7428		1.0296	
HOS	InTL	HOS/HOI	InS/HOS	ODT %	TDT %
81.6178	70.9539	13.6030	0.3451	−113.2790	84.4806
HVT11	HVT12	HVT21	HVT22	HVT31	HVT32
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HVT61	HVT62	HVT71	HVT72	HVT72/HOI	HVT72/ HOS
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PhiA	PhiC	PhiD	TH1	TH2	HOI
11.962 mm	12.362 mm	12.862 mm	0.25 mm	0.2 mm	6 mm
PhiA/ PhiD	TH1 + TH2	(TH1 + TH2)/ HOI	(TH1 + TH2)/ HOS	2(TH1 + TH2)/ PhiA	InTL/HOS
0.9676	0.45 mm	0.075	0.0055	0.0752	0.8693
PSTA	PLTA	NSTA	NLTA	SSTA	SLTA
0.060 mm	−0.005 mm	0.016 mm	0.006 mm	0.020 mm	−0.008 mm

The values stated as follows may be deduced according to Table 3 and Table 4.

The second optical embodiment (Primary reference wavelength: 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/HEP) %	TP	ARE/TP (%)
11	1.082	1.081	−0.00075	99.93%	4.977	21.72%
12	1.082	1.083	0.00149	100.14%	4.977	21.77%
21	1.082	1.082	0.00011	100.01%	5.000	21.64%
22	1.082	1.082	−0.00034	99.97%	5.000	21.63%
31	1.082	1.081	−0.00084	99.92%	5.000	21.62%
32	1.082	1.081	−0.00075	99.93%	5.000	21.62%
41	1.082	1.081	−0.00059	99.95%	4.095	26.41%
42	1.082	1.081	−0.00067	99.94%	4.095	26.40%
51	1.082	1.082	−0.00021	99.98%	1.539	70.28%
52	1.082	1.081	−0.00069	99.94%	1.539	70.25%
61	1.082	1.082	−0.00021	99.98%	5.000	21.63%
62	1.082	1.082	0.00005	100.00%	5.000	21.64%
71	1.082	1.082	−0.00003	100.00%	4.933	21.93%
72	1.082	1.083	0.00083	100.08%	4.933	21.95%
ARS	EHD	ARS value	ARS − EHD	(ARS/EHD) %	TP	ARS/TP (%)
11	20.767	21.486	0.719	103.46%	4.977	431.68%
12	9.412	13.474	4.062	143.16%	4.977	270.71%
21	8.636	9.212	0.577	106.68%	5.000	184.25%
22	9.838	10.264	0.426	104.33%	5.000	205.27%
31	8.770	8.772	0.003	100.03%	5.000	175.45%
32	8.511	8.558	0.047	100.55%	5.000	171.16%
41	4.600	4.619	0.019	100.42%	4.095	112.80%
42	4.965	4.981	0.016	100.32%	4.095	121.64%
51	5.075	5.143	0.067	101.33%	1.539	334.15%
52	5.047	5.062	0.015	100.30%	1.539	328.89%

-continued

The second optical embodiment (Primary reference wavelength: 555 nm)						
61	5.011	5.075	0.064	101.28%	5.000	101.50%
62	5.373	5.489	0.116	102.16%	5.000	109.79%
71	5.513	5.625	0.112	102.04%	4.933	114.03%
72	5.981	6.307	0.326	105.44%	4.933	127.84%

The values stated as follows may be deduced according to Table 3 and Table 4.

Related inflection point values of second optical embodiment (Primary reference wavelength: 555 nm)							
HIF111	0	HIF111/HOI	0	SGI111	0	|SGI111|/ (|SGI111| + TP1)	0

The Third Optical Embodiment

As shown in FIG. **20**, the fixed-focus lens assembly **230** may include six lenses **2401** with refractive power, which are a first lens **2411**, a second lens **2421**, a third lens **2431**, a four lens **2441**, a fifth lens **2451**, and a sixth lens **2461** sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly **230** satisfies the following condition: 0.1≤InTL/HOS≤0.95. Specifically, HOS is the distance from an object side surface of the first lens **2411** to the imaging surface on an optical axis. InTL is the distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the sixth lens **2461**.

Please refer to FIG. **26** and FIG. **27**. FIG. **26** is a schematic diagram of the optical image capturing module according to the third optical embodiment of the present invention. FIG. **27** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the third optical embodiment of the present invention. As shown in FIG. **26**, the optical image capturing module includes a first lens **2411**, a second lens **2421**, a third lens **2431**, an aperture **250**, a four lens **2441**, a fifth lens **2451**, a sixth lens **2461**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has negative refractive power and is made of a glass material. The object side surface **24112** thereof is a convex surface and the image side surface **24114** thereof is a concave surface, both of which are spherical.

The second lens **2421** has negative refractive power and is made of a glass material. The object side surface thereof **24212** is a concave surface and the image side surface thereof **24214** is a convex surface, both of which are spherical.

The third lens **2431** has positive refractive power and is made of a glass material. The object side surface **24312** thereof is a convex surface and the image side surface **24314** thereof is a convex surface, both of which are aspheric. The object side surface **334** thereof has an inflection point.

The fourth lens **2441** has negative refractive power and is made of a plastic material. The object side surface thereof **24412** is a concave surface and the image side surface thereof **24414** is a concave surface, both of which are aspheric. The image side surface **24414** thereof both have an inflection point.

The fifth lens **2451** has positive refractive power and is made of a plastic material. The object side surface **24512** thereof is a convex surface and the image side surface **24514** thereof is a convex surface, both of which are aspheric.

The sixth lens **2461** has negative refractive power and is made of a plastic material. The object side surface **24612** thereof is a convex surface and the image side surface **24614** thereof is a concave surface. The object side surface **24612** and the image side surface **24614** thereof both have an inflection point. Therefore, it is advantageous for the lens to reduce the back focal length to maintain minimization. In addition, it is effective to suppress the incident angle with incoming light from an off-axis view field and further correct the aberration in the off-axis view field.

The IR-cut filter **300** is made of glass and is disposed between the sixth lens **2461** and the image plane **600**, which does not affect the focal length of the optical image capturing module.

Please refer to the following Table 5 and Table 6.

TABLE 5

Data of the optical image capturing module of the third optical embodiment
f = 2.808 mm; f/HEP = 1.6; HAF = 100 deg

Surface		Curvature radius	Thickness (mm)	Material
0	Object	1E+18	1E+18	
1	Lens 1	71.398124	7.214	Glass
2		7.117272355	5.788	
3	Lens 2	−13.29213699	10.000	Glass
4		−18.37509887	7.005	
5	Lens 3	5.039114804	1.398	Plastic
6		−15.53136631	−0.140	
7	Aperture	1E+18	2.378	
8	Lens 4	−18.68613609	0.577	Plastic
9		4.086545927	0.141	
10	Lens 5	4.927609282	2.974	Plastic
11		−4.551946605	1.389	
12	Lens 6	9.184876531	1.916	Plastic
13		4.845500046	0.800	
14	IR-cut filter	1E+18	0.500	BK_7
15		1E+18	0.371	
16	image plane	1E+18	0.005	

Surface	Refractive Index	Dispersion coefficient	Focal length
0			
1	1.702	41.15	−11.765
2			
3	2.003	19.32	−4537.460
4			
5	1.514	56.80	7.553
6			
7			
8	1.661	20.40	−4.978
9			
10	1.565	58.00	4.709
11			
12	1.514	56.80	−23.405
13			
14	1.517	64.13	
15			
16			

Reference wavelength (d-line) = 555 nm

TABLE 6

The aspheric surface parameters of the third optical embodiment
Aspheric Coefficients

	Surface No 1	2	3	4
k	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A4	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A6	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A8	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A10	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

TABLE 6-continued

The aspheric surface parameters of the third optical embodiment
Aspheric Coefficients

	Surface No			
	5	6	8	9
k	1.318519E−01	3.120384E+00	−1.494442E+01	2.744228E−02
A4	6.405246E−05	2.103942E−03	−1.598286E−03	−7.291825E−03
A6	2.278341E−05	−1.050629E−04	−9.177115E−04	9.730714E−05
A8	−3.672908E−06	6.168906E−06	1.011405E−04	1.101816E−06
A10	3.748457E−07	−1.224682E−07	−4.919835E−06	−6.849076E−07
	Surface No			
	10	11	12	13
k	−7.864013E+00	−2.263702E+00	−4.206923E+01	−7.030803E+00
A4	1.405243E−04	−3.919567E−03	−1.679499E−03	−2.640099E−03
A6	1.837602E−04	2.683449E−04	−3.518520E−04	−4.507651E−05
A8	−2.173368E−05	−1.229452E−05	5.047353E−05	−2.600391E−05
A10	7.328496E−07	4.222621E−07	−3.851055E−06	1.161811E−06

In the third optical embodiment, the aspheric surface formula is presented in the same way in the first optical embodiment. In addition, the definitions of parameters in following tables are the same as those in the first optical embodiment. Therefore, similar description shall not be illustrated again.

The values stated as follows may be deduced according to Table 5 and Table 6.

Third optical embodiment (Primary reference wavelength: 555 nm)					
|f/f1|	|f/f2|	|f/f3|	|f/f4|	|f/f5|	|f/f6|
0.23865	0.00062	0.37172	0.56396	0.59621	0.11996
ΣPPR	ΣNPR	ΣPPR/ |ΣNPR|	IN12/f	IN56/f	TP4/ (IN34 + TP4 + IN45)
1.77054	0.12058	14.68400	2.06169	0.49464	0.19512
|f1/f2|	|f2/f3|	(TP1 + IN12)/TP2		(TP6 + IN56)/TP5	
0.00259	600.74778	1.30023		1.11131	
HOS	InTL	HOS/HOI	InS/HOS	ODT %	TDT %
42.31580	40.63970	10.57895	0.26115	−122.32700	93.33510
HVT51	HVT52	HVT61	HVT62	HVT62/HOI	HVT62/HOS
0	0	2.22299	2.60561	0.65140	0.06158
TP2/ TP3	TP3/ TP4	InRS61	InRS62	|InRS61|/ TP6	|InRS62|/TP6
7.15374	2.42321	−0.20807	−0.24978	0.10861	0.13038
PhiA	PhiC	PhiD	TH1	TH2	HOI
6.150 mm	6.41 mm	6.71 mm	0.15 mm	0.13 mm	4 mm
PhiA/ PhiD	TH1 + TH2	(TH1 + TH2)/ HOI	(TH1 + TH2)/ HOS	2(TH1 + TH2)/ PhiA	InTL/HOS
0.9165	0.28 mm	0.07	0.0066	0.0911	0.9604
PSTA	PLTA	NSTA	NLTA	SSTA	SLTA
0.014 mm	0.002 mm	−0.003 mm	−0.002 mm	0.011 mm	−0.001 mm

The values related to arc lengths may be obtained according to table 5 and table 6.

Third optical embodiment (Reference wavelength = 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/HEP) %	TP	ARE/TP (%)
11	0.877	0.877	−0.00036	99.96%	7.214	12.16%
12	0.877	0.879	0.00186	100.21%	7.214	12.19%
21	0.877	0.878	0.00026	100.03%	10.000	8.78%
22	0.877	0.877	−0.00004	100.00%	10.000	8.77%
31	0.877	0.882	0.00413	100.47%	1.398	63.06%
32	0.877	0.877	0.00004	100.00%	1.398	62.77%
41	0.877	0.877	−0.00001	100.00%	0.577	152.09%
42	0.877	0.883	0.00579	100.66%	0.577	153.10%
51	0.877	0.881	0.00373	100.43%	2.974	29.63%
52	0.877	0.883	0.00521	100.59%	2.974	29.68%
61	0.877	0.878	0.00064	100.07%	1.916	45.83%
62	0.877	0.881	0.00368	100.42%	1.916	45.99%
ARS	EHD	ARS value	ARS − EHD	(ARS/EHD) %	TP	ARS/TP (%)
11	17.443	17.620	0.178	101.02%	7.214	244.25%
12	6.428	8.019	1.592	124.76%	7.214	111.16%
21	6.318	6.584	0.266	104.20%	10.000	65.84%
22	6.340	6.472	0.132	102.08%	10.000	64.72%
31	2.699	2.857	0.158	105.84%	1.398	204.38%
32	2.476	2.481	0.005	100.18%	1.398	177.46%
41	2.601	2.652	0.051	101.96%	0.577	459.78%
42	3.006	3.119	0.113	103.75%	0.577	540.61%
51	3.075	3.171	0.096	103.13%	2.974	106.65%
52	3.317	3.624	0.307	109.24%	2.974	121.88%
61	3.331	3.427	0.095	102.86%	1.916	178.88%
62	3.944	4.160	0.215	105.46%	1.916	217.14%

The values stated as follows may be deduced according to Table 5 and Table 6.

Related inflection point values of third optical embodiment (Primary reference wavelength: 555 nm)							
HIF321	2.0367	HIF321/HOI	0.5092	SGI321	−0.1056	|SGI321|/(|SGI321| + TP3)	0.0702
HIF421	2.4635	HIF421/HOI	0.6159	SGI421	0.5780	|SGI421|/(|SGI421| + TP4)	0.5005
HIF611	1.2364	HIF611/HOI	0.3091	SGI611	0.0668	|SGI611|/(|SGI611| + TP6)	0.0337
HIF621	1.5488	HIF621/HOI	0.3872	SGI621	0.2014	|SGI621|/(|SGI621| + TP6)	0.0951

The Fourth Optical Embodiment

As shown in FIG. **19**, the fixed-focus lens assembly **230** may include five lenses **2401** with refractive power, which are a first lens **2411**, a second lens **2421**, a third lens **2431**, a four lens **2441**, a fifth lens **2451** sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly **230** satisfies the following condition: 0.1≤InTL/HOS≤0.95. Specifically, HOS is the distance on the optical axis from an object side surface of the first lens **2411** to the image plane; InTL is the distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the fifth lens **2451**.

Please refer to FIG. **28** and FIG. **29**. FIG. **28** is a schematic diagram of the optical image capturing module according to the fourth optical embodiment of the present invention. FIG. **29** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the fourth optical embodiment of the present invention. As shown in FIG. **28**, the optical image capturing module includes a first lens **2411**, a second lens **2421**, a third lens **2431**, an aperture **250**, a four lens **2441**, a fifth lens **2451**, a sixth lens **2461**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has negative refractive power and is made of a glass material. The object side surface **24112** thereof is a convex surface and the image side surface **24114** thereof is a concave surface, both of which are spherical.

The second lens **2421** has negative refractive power and is made of a plastic material. The object side surface thereof **24212** is a concave surface and the image side surface thereof **24214** is a concave surface, both of which are aspheric. The object side surface **24212** has an inflection point.

The third lens **2431** has positive refractive power and is made of a plastic material. The object side surface **24312** thereof is a convex surface and the image side surface **24314** thereof is a convex surface, both of which are aspheric. The object side surface **24312** thereof has an inflection point.

The fourth lens **2441** has positive refractive power and is made of a plastic material. The object side surface **24412** thereof is a convex surface and the image side surface **24414** thereof is a concave surface, both of which are aspheric. The object side surface **24412** thereof has an inflection point.

The fifth lens **2451** has negative refractive power and is made of a plastic material. The object side surface thereof **24512** is a concave surface and the image side surface thereof **24514** is a concave surface, both of which are aspheric. The object side surface **24512** has two inflection points. Therefore, it is advantageous for the lens to reduce the back focal length to maintain minimization.

The IR-cut filter **300** is made of glass and is disposed between the fifth lens **2451** and the image plane **600**, which does not affect the focal length of the optical image capturing module.

Please refer to the following Table 7 and Table 8.

TABLE 7

Data of the optical image capturing module of the fourth optical embodiment f = 2.7883 mm; f/HEP = 1.8; HAF = 101 deg				
Surface		Curvature radius	Thickness (mm)	Material
0	Object	1E+18	1E+18	
1	Lens 1	76.84219	6.117399	Glass
2		12.62555	5.924382	
3	Lens 2	−37.0327	3.429817	Plastic
4		5.88556	5.305191	
5	Lens 3	17.99395	14.79391	

TABLE 7-continued

Data of the optical image capturing module of the fourth optical embodiment f = 2.7883 mm; f/HEP = 1.8; HAF = 101 deg				
6		−5.76903	−0.4855	Plastic
7	Aperture	1E+18	0.535498	
8	Lens 4	8.19404	4.011739	Plastic
9		−3.84363	0.050366	
10	Lens 5	−4.34991	2.088275	Plastic
11		16.6609	0.6	
12	IR-cut filter	1E+18	0.5	BK_7
13		1E+18	3.254927	
14	Image plane	1E+18	−0.00013	

Surface	Refractive index	Dispersion coefficient	Focal length
0			
1	1.497	81.61	−31.322
2			
3	1.565	54.5	−8.70843
4			
5			
6	1.565	58	9.94787
7			
8	1.565	58	5.24898
9			
10	1.661	20.4	−4.97515
11			
12	1.517	64.13	
13			
14			

Reference wavelength (d-line) = 555 nm

Table 8. The aspheric surface parameters of the fourth optical embodiment

TABLE 8

The aspheric surface parameters of the fourth optical embodiment
Aspheric Coefficients

	Surface			
	1	2	3	4
k	0.000000E+00	0.000000E+00	0.131249	−0.069541
A4	0.000000E+00	0.000000E+00	3.99823E−05	−8.55712E−04
A6	0.000000E+00	0.000000E+00	9.03636E−08	−1.96175E−06
A8	0.000000E+00	0.000000E+00	1.91025E−09	−1.39344E−08
A10	0.000000E+00	0.000000E+00	−1.18567E−11	−4.17090E−09
A12	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

	Surface			
	5	6	8	9
k	−0.324555	0.009216	−0.292346	−0.18604
A4	−9.07093E−04	8.80963E−04	−1.02138E−03	4.33629E−03
A6	−1.02465E−05	3.14497E−05	−1.18559E−04	−2.91588E−04
A8	−8.18157E−08	−3.15863E−06	1.34404E−05	9.11419E−06
A10	−2.42621E−09	1.44613E−07	−2.80681E−06	1.28365E−07
A12	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00

	Surface	
	10	11
k	−6.17195	27.541383
A4	1.58379E−03	7.56932E−03
A6	−1.81549E−04	−7.83858E−04
A8	−1.18213E−05	4.79120E−05
A10	1.92716E−06	−1.73591E−06
A12	0.000000E+00	0.000000E+00

In the fourth optical embodiment, the aspheric surface formula is presented in the same way in the first optical embodiment. In addition, the definitions of parameters in following tables are the same as those in the first optical embodiment. Therefore, similar description shall not be illustrated again.

The values stated as follows may be deduced according to Table 7 and Table 8.

Fourth optical embodiment (Primary reference wavelength: 555 nm)					
|f/f1|	|f/f2|	|f/f3|	|f/f4|	|f/f5|	|f1/f2|
0.08902	0.32019	0.28029	0.53121	0.56045	3.59674
ΣPPR	ΣNPR	ΣPPR/ |ΣNPR|	IN12/f	IN45/f	|f2/f3|
1.4118	0.3693	3.8229	2.1247	0.0181	0.8754
TP3/ (IN23 + TP3 + IN34)		(TP1 + IN12)/TP2		(TP5 + IN45)/TP4	
0.73422		3.51091		0.53309	
HOS	InTL	HOS/HOI	InS/HOS	ODT %	TDT %
46.12590	41.77110	11.53148	0.23936	−125.266	99.1671
HVT41	HVT42	HVT51	HVT52	HVT52/HOI	HVT52/ HOS
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TP2/ TP3	TP3/TP4	InRS51	InRS52	|InRS51|/ TP5	|InRS52|/ TP5
0.23184	3.68765	−0.679265	0.5369	0.32528	0.25710
PhiA	PhiC	PhiD	TH1	TH2	HOI
5.598 mm	5.858 mm	6.118 mm	0.13 mm	0.13 mm	4 mm
PhiA/ PhiD	TH1 + TH2	(TH1 + TH2)/ HOI	(TH1 + TH2)/ HOS	2(TH1 + TH2)/ PhiA	InTL/HOS
0.9150	0.26 mm	0.065	0.0056	0.0929	0.9056
PSTA	PLTA	NSTA	NLTA	SSTA	SLTA
−0.011 mm	0.005 mm	−0.010 mm	−0.003 mm	0.005 mm	−0.00026 mm

The values related to are lengths may be obtained according to table 7 and table 8.

Fourth optical embodiment (Reference wavelength = 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/ HEP) %	TP	ARE/TP (%)
11	0.775	0.774	−0.00052	99.93%	6.117	12.65%
12	0.775	0.774	−0.00005	99.99%	6.117	12.66%
21	0.775	0.774	−0.00048	99.94%	3.430	22.57%
22	0.775	0.776	0.00168	100.22%	3.430	22.63%
31	0.775	0.774	−0.00031	99.96%	14.794	5.23%
32	0.775	0.776	0.00177	100.23%	14.794	5.25%
41	0.775	0.775	0.00059	100.08%	4.012	19.32%
42	0.775	0.779	0.00453	100.59%	4.012	19.42%
51	0.775	0.778	0.00311	100.40%	2.088	37.24%
52	0.775	0.774	−0.00014	99.98%	2.088	37.08%

-continued

Fourth optical embodiment (Reference wavelength = 555 nm)						
ARS	EHD	ARS value	ARS − EHD	(ARS/ EHD) %	TP	ARS/TP (%)
11	23.038	23.397	0.359	101.56%	6.117	382.46%
12	10.140	11.772	1.632	116.10%	6.117	192.44%
21	10.138	10.178	0.039	100.39%	3.430	296.74%
22	5.537	6.337	0.800	114.44%	3.430	184.76%
31	4.490	4.502	0.012	100.27%	14.794	30.43%
32	2.544	2.620	0.076	102.97%	14.794	17.71%
41	2.735	2.759	0.024	100.89%	4.012	68.77%
42	3.123	3.449	0.326	110.43%	4.012	85.97%
51	2.934	3.023	0.089	103.04%	2.088	144.74%
52	2.799	2.883	0.084	103.00%	2.088	138.08%

The values stated as follows may be deduced according to Table 7 and Table 8.

Related inflection point values of fourth optical embodiment (Primary reference wavelength: 555 nm)							
HIF211	6.3902	HIF211/ HOI	1.5976	SGI211	−0.4793	|SGI211|/ (|SGI211| + TP2)	0.1226
HIF311	2.1324	HIF311/ HOI	0.5331	SGI311	0.1069	|SGI311|/ (|SGI311| + TP3)	0.0072
HIF411	2.0278	HIF411/ HOI	0.5070	SGI411	0.2287	|SGI411|/ (|SGI411| + TP4)	0.0539

-continued

Related inflection point values of fourth optical embodiment (Primary reference wavelength: 555 nm)							
HIF511	2.6253	HIF511/HOI	0.6563	SGI511	−0.5681	|SGI511|/(|SGI511| + TP5)	0.2139
HIF512	2.1521	HIF512/HOI	0.5380	SGI512	−0.8314	|SGI512|/(|SGI512| + TP5)	0.2848

The Fifth Optical Embodiment

As shown in FIG. **18**, the fixed-focus lens assembly **230** may include fourth lenses with refractive power, which are a first lens **2411**, a second lens **2421**, a third lens **2431**, and a four lens **2441** sequentially displayed from an object side surface to an image side surface. The fixed-focus lens assembly **230** satisfies the following condition: 0.1≤InTL/HOS≤0.95. Specifically, HOS is the distance on the optical axis from an object side surface of the first lens **2411** to the image plane; InTL is the distance on the optical axis from an object side surface of the first lens **2411** to an image side surface of the fourth lens **2441**.

Please refer to FIG. **30** and FIG. **31**. FIG. **30** is a schematic diagram of the optical image capturing module according to the fifth optical embodiment of the present invention. FIG. **31** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the fifth optical embodiment of the present invention. As shown in FIG. **30**, the optical image capturing module includes an aperture **250**, a first lens **2411**, a second lens **2421**, a third lens **2431**, a four lens **2441**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has positive refractive power and is made of a plastic material. The object side surface **24112** thereof is a convex surface and the image side surface **24114** thereof is a convex surface, both of which are aspheric. The object side surface **24112** thereof has an inflection point.

The second lens **2421** has negative refractive power and is made of a plastic material. The object side surface thereof **24212** is a convex surface and the image side surface thereof **24214** is a concave surface, both of which are aspheric. The object side surface **24212** has two inflection points and the image side surface **24214** thereof has an inflection point.

The third lens **2431** has positive refractive power and is made of a plastic material. The object side surface **24312** thereof is a concave surface and the image side surface **24314** thereof is a convex surface, both of which are aspheric. The object side surface **24312** thereof has three inflection points and the image side surface **24314** thereof has an inflection point.

The fourth lens **2441** has negative refractive power and is made of a plastic material. The object side surface thereof **24412** is a concave surface and the image side surface thereof **24414** is a concave surface, both of which are aspheric. The object side surface thereof **24412** has two inflection points and the image side surface **24414** thereof has an inflection point.

The IR-cut filter **300** is made of glass and is disposed between the fourth lens **2441** and the image plane **600**, which does not affect the focal length of the optical image capturing module.

Please refer to the following Table 9 and Table 10.

TABLE 9

Data of the optical image capturing module of the fifth optical embodiment
f = 1.04102 mm; f/HEP = 1.4; HAF = 44.0346 deg

Surface		Curvature Radius	Thickness (mm)	Material
0	Object	1E+18	600	
1	Aperture	1E+18	−0.020	
2	Lens 1	0.890166851	0.210	Plastic
3		−29.11040115	−0.010	
4		1E+18	0.116	
5	Lens 2	10.67765398	0.170	Plastic
6		4.977771922	0.049	
7	Lens 3	−1.191436932	0.349	Plastic
8		−0.248990674	0.030	
9	Lens 4	−38.08537212	0.176	Plastic
10		0.372574476	0.152	
11	IR-cut filter	1E+18	0.210	BK_7
12		1E+18	0.185	
13	Image plane	1E+18	0.005	

Surface	Refractive index	Dispersion coefficient	Focal length
0			
1			
2	1.545	55.96	1.587
3			
4			
5	1.642	22.46	−14.569
6			
7	1.545	55.96	0.510
8			
9	1.642	22.46	−0.569
10			
11	1.517	64.13	
12			
13			

Reference wavelength (d-line) = 555 nm.
Shield position: The radius of the clear aperture of the fourth surface is 0.360 mm.

TABLE 10

The aspheric surface parameters of the fifth optical embodiment
Aspheric Coefficients

	Surface			
	2	3	5	6
k =	−1.106629E+00	2.994179E−07	−7.788754E+01	−3.440335E+01
A4 =	8.291155E−01	−6.401113E−01	−4.958114E+00	−1.875957E+00

TABLE 10-continued

The aspheric surface parameters of the fifth optical embodiment Aspheric Coefficients				
A6 =	−2.398799E+01	−1.265726E+01	1.299769E+02	8.568480E+01
A8 =	1.825378E+02	8.457286E+01	−2.736977E+03	−1.279044E+03
A10 =	−6.211133E+02	−2.157875E+02	2.908537E+04	8.661312E+03
A12 =	−4.719066E+02	−6.203600E+02	−1.499597E+05	−2.875274E+04
A14 =	0.000000E+00	0.000000E+00	2.992026E+05	3.764871E+04
A16 =	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A18 =	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
A20 =	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
	Surface			
	7	8	9	10
k =	−8.522097E−01	−4.735945E+00	−2.277155E+01	−8.039778E−01
A4 =	−4.878227E−01	−2.490377E+00	1.672704E+01	−7.613206E+00
A6 =	1.291242E+02	1.524149E+02	−3.260722E+02	3.374046E+01
A8 =	−1.979689E+03	−4.841033E+03	3.373231E+03	−1.368453E+02
A10 =	1.456076E+04	8.053747E+04	−2.177676E+04	4.049486E+02
A12 =	−5.975920E+04	−7.936887E+05	8.951687E+04	−9.711797E+02
A14 =	1.351676E+05	4.811528E+06	−2.363737E+05	1.942574E+03
A16 =	−1.329001E+05	−1.762293E+07	3.983151E+05	−2.876356E+03
A18 =	0.000000E+00	3.579891E+07	−4.090689E+05	2.562386E+03
A20 =	0.000000E+00	−3.094006E+07	2.056724E+05	−9.943657E+02

In the fifth optical embodiment, the aspheric surface formula is presented in the same way in the first optical embodiment. In addition, the definitions of parameters in following tables are the same as those in the first optical embodiment. Therefore, similar description shall not be illustrated again.

The values stated as follows may be deduced according to Table 9 and Table 10.

Fifth optical embodiment (Primary reference wavelength: 555 nm)					
InRS41	InRS42	HVT41	HVT42	ODT %	TDT %
−0.07431	0.00475	0.00000	0.53450	2.09403	0.84704
|f/f1|	|f/f2|	|f/f3|	|f/f4|	|f1/f2|	|f2/f3|
0.65616	0.07145	2.04129	1.83056	0.10890	28.56826
ΣPPR	ΣNPR	ΣPPR/ |ΣNPR|	ΣPP	ΣNP	f1/ΣPP
2.11274	2.48672	0.84961	−14.05932	1.01785	1.03627
f4/ΣNP	IN12/f	IN23/f	IN34/f	TP3/f	TP4/f
1.55872	0.10215	0.04697	0.02882	0.33567	0.16952
InTL	HOS	HOS/HOI	InS/HOS	InTL/HOS	ΣTP/ InTL
1.09131	1.64329	1.59853	0.98783	0.66410	0.83025
(TP1 + IN12)/ TP2	(TP4 + IN34)/ TP3	TP1/TP2	TP3/TP4	IN23/(TP2 + IN23 + TP3)	
1.86168	0.59088	1.23615	1.98009	0.08604	
|InRS41|/ TP4	|InRS42|/ TP4	HVT42/HOI	HVT42/ HOS	InTL/HOS	
0.4211	0.0269	0.5199	0.3253	0.6641	

-continued

Fifth optical embodiment (Primary reference wavelength: 555 nm)					
PhiA	PhiC	PhiD	TH1	TH2	HOI
1.596 mm	1.996 mm	2.396 mm	0.2 mm	0.2 mm	1.028 mm
PhiA/PhiD	TH1 + TH2	(TH1 + TH2)/ HOI	(TH1 + TH2)/ HOS	2(TH1 + TH2)/ PhiA	
0.7996	0.4 mm	0.3891	0.2434	0.5013	
PSTA	PLTA	NSTA	NLTA	SSTA	SLTA
−0.029 mm	−0.023 mm	−0.011 mm	−0.024 mm	0.010 mm	0.011 mm

The values stated as follows may be deduced according to Table 9 and Table 10.

Related inflection point values of fifth optical embodiment (Primary reference wavelength: 555 nm)							
HIF111	0.28454	HIF111/ HOI	0.27679	SGI111	0.04361	|SGI111|/ (|SGI111| + TP1)	0.17184
HIF211	0.04198	HIF211/ HOI	0.04083	SGI211	0.00007	|SGI211|/ (|SGI211| + TP2)	0.00040
HIF212	0.37903	HIF212/ HOI	0.36871	SGI212	−0.03682	|SGI212|/ (|SGI212| + TP2)	0.17801
HIF221	0.25058	HIF221/ HOI	0.24376	SGI221	0.00695	|SGI221|/ (|SGI221| + TP2)	0.03927
HIF311	0.14881	HIF311/ HOI	0.14476	SGI311	−0.00854	|SGI311|/ (|SGI311| + TP3)	0.02386
HIF312	0.31992	HIF312/ HOI	0.31120	SGI312	−0.01783	|SGI312|/ (|SGI312| + TP3)	0.04855
HIF313	0.32956	HIF313/ HOI	0.32058	SGI313	−0.01801	|SGI313|/ (|SGI313| + TP3)	0.04902
HIF321	0.36943	HIF321/ HOI	0.35937	SGI321	−0.14878	|SGI321|/ (|SGI321| + TP3)	0.29862
HIF411	0.01147	HIF411/ HOI	0.01116	SGI411	−0.00000	|SGI411|/ (|SGI411| + TP4)	0.00001
HIF412	0.22405	HIF412/ HOI	0.21795	SGI412	0.01598	|SGI412|/ (|SGI412| + TP4)	0.08304
HIF421	0.24105	HIF421/ HOI	0.23448	SGI421	0.05924	|SGI421|/ (|SGI421| + TP4)	0.25131

The values related to arc lengths may be obtained according to table 9 and table 10.

Fifth optical embodiment (Reference wavelength = 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/HEP) %	TP	ARE/TP (%)
11	0.368	0.374	0.00578	101.57%	0.210	178.10%
12	0.366	0.368	0.00240	100.66%	0.210	175.11%
21	0.372	0.375	0.00267	100.72%	0.170	220.31%
22	0.372	0.371	−0.00060	99.84%	0.170	218.39%
31	0.372	0.372	−0.00023	99.94%	0.349	106.35%
32	0.372	0.404	0.03219	108.66%	0.349	115.63%
41	0.372	0.373	0.00112	100.30%	0.176	211.35%
42	0.372	0.387	0.01533	104.12%	0.176	219.40%

-continued

Fifth optical embodiment (Reference wavelength = 555 nm)						
ARS	EHD	ARS value	ARS − EHD	(ARS/EHD) %	TP	ARS/TP (%)
11	0.368	0.374	0.00578	101.57%	0.210	178.10%
12	0.366	0.368	0.00240	100.66%	0.210	175.11%
21	0.387	0.391	0.00383	100.99%	0.170	229.73%
22	0.458	0.460	0.00202	100.44%	0.170	270.73%
31	0.476	0.478	0.00161	100.34%	0.349	136.76%
32	0.494	0.538	0.04435	108.98%	0.349	154.02%
41	0.585	0.624	0.03890	106.65%	0.176	353.34%
42	0.798	0.866	0.06775	108.49%	0.176	490.68%

The Sixth Optical Embodiment

Please refer to FIG. **32** and FIG. **33**. FIG. **32** is a schematic diagram of the optical image capturing module according to the sixth optical embodiment of the present invention. FIG. **33** is a curve diagram of spherical aberration, astigmatism, and optical distortion of the optical image capturing module sequentially displayed from left to right according to the sixth optical embodiment of the present invention. As shown in FIG. **32**, the optical image capturing module includes a first lens **2411**, an aperture **250**, a second lens **2421**, a third lens **2431**, an IR-cut filter **300**, an image plane **600**, and image sensor elements **140** sequentially displayed from an object side surface to an image side surface.

The first lens **2411** has positive refractive power and is made of a plastic material. The object side surface **24112** thereof is a convex surface and the image side surface **24114** thereof is a concave surface, both of which are aspheric.

The second lens **2421** has negative refractive power and is made of a plastic material. The object side surface thereof **24212** is a concave surface and the image side surface thereof **24214** is a convex surface, both of which are aspheric. The image side surface **24214** thereof both has an inflection point.

The third lens **2431** has positive refractive power and is made of a plastic material. The object side surface **24312** thereof is a convex surface and the image side surface **24314** thereof is a concave surface, both of which are aspheric. The object side surface **24312** thereof has two inflection points and the image side surface **24314** thereof has an infection point.

The IR-cut filter **300** is made of glass and is disposed between the third lens **2431** and the image plane **600**, which does not affect the focal length of the optical image capturing module.

Please refer to the following Table 11 and Table 12.

TABLE 11

Data of the optical image capturing module of the sixth optical embodiment
f = 2.41135 mm; f/HEP = 2.22; HAF = 36 deg

Surface		Curvature radius	Thickness (mm)	Material
0	Object	1E+18	600	
1	Lens 1	0.840352226	0.468	Plastic
2		2.271975602	0.148	
3	Aperture	1E+18	0.277	
4	Lens 2	−1.157324239	0.349	Plastic
5		−1.968404008	0.221	
6	Lens 3	1.151874235	0.559	Plastic
7		1.338105159	0.123	
8	IR-cut filter	1E+18	0.210	BK7
9		1E+18	0.547	
10	Image plane	1E+18	0.000	

Surface	Refractive index	Dispersion coefficient	Focal length
0			
1	1.535	56.27	2.232
2			
3			
4	1.642	22.46	−5.221
5			
6	1.544	56.09	7.360
7			
8	1.517	64.13	
9			
10			

Reference wavelength (d-line) = 555 nm.
Shield position: The radius of the clear aperture of the first surface is 0.640 mm

TABLE 12

The aspheric surface parameters of the sixth optical embodiment
Aspheric Coefficients

	Surface			
	1	2	4	5
k =	−2.019203E−01	1.528275E+01	3.743939E+00	−1.207814E+01
A4 =	3.944883E−02	−1.670490E−01	−4.266331E−01	−1.696843E+00
A6 =	4.774062E−01	3.857435E+00	−1.423859E+00	5.164775E+00
A8 =	−1.528780E+00	−7.091408E+01	4.119587E+01	−1.445541E+01
A10 =	5.133947E+00	6.365801E+02	−3.456462E+02	2.876958E+01
A12 =	−6.250496E+00	−3.141002E+03	1.495452E+03	−2.662400E+01
A14 =	1.068803E+00	7.962834E+03	−2.747802E+03	1.661634E+01
A16 =	7.995491E+00	−8.268637E+03	1.443133E+03	−1.327827E+01

	Surface	
	6	7
k =	−1.276860E+01	−3.034004E+00
A4 =	−7.396546E−01	−5.308488E−01
A6 =	4.449101E−01	4.374142E−01
A8 =	2.622372E−01	−3.111192E−01
A10 =	−2.510946E−01	1.354257E−01
A12 =	−1.048030E−01	−2.652902E−02
A14 =	1.462137E−01	−1.203306E−03
A16 =	−3.676651E−02	7.805611E−04

In the sixth optical embodiment, the aspheric surface formula is presented in the same way in the first optical embodiment. In addition, the definitions of parameters in following tables are the same as those in the first optical embodiment. Therefore, similar description shall not be illustrated again.

The values stated as follows may be deduced according to Table 11 and Table 12.

Sixth optical embodiment (Primary reference wavelength: 555 nm)					
|f/f1|	|f/f2|	|f/f3|	|f1/f2|	|f2/f3|	TP1/TP2
1.08042	0.46186	0.32763	2.33928	1.40968	1.33921
ΣPPR	ΣNPR	ΣPPR/ |ΣNPR|	IN12/f	IN23/f	TP2/TP3
1.40805	0.46186	3.04866	0.17636	0.09155	0.62498
TP2/ (IN12 + TP2 + IN23)		(TP1 + IN12)/TP2		(TP3 + IN23)/TP2	
0.35102		2.23183		2.23183	
HOS	InTL	HOS/HOI	InS/HOS	|ODT| %	|TDT| %
2.90175	2.02243	1.61928	0.78770	1.50000	0.71008
HVT21	HVT22	HVT31	HVT32	HVT32/HOI	HVT32/ HOS
0.00000	0.00000	0.46887	0.67544	0.37692	0.23277
PhiA	PhiC	PhiD	TH1	TH2	HOI
2.716 mm	3.116 mm	3.616 mm	0.25 mm	0.2 mm	1.792 mm
PhiA/ PhiD	TH1 + TH2	(TH1 + TH2)/ HOI	(TH1 + TH2)/ HOS	2(TH1 + TH2)/ PhiA	InTL/HOS
0.7511	0.45 mm	0.2511	0.1551	0.3314	0.6970
PLTA	PSTA	NLTA	NSTA	SLTA	SSTA
−0.002 mm	0.008 mm	0.006 mm	−0.008 mm	−0.007 mm	0.006 mm

The values stated as follows may be deduced according to Table 11 and Table 12.

Related inflection point values of sixth optical embodiment (Primary reference wavelength: 555 nm)							
HIF221	0.5599	HIF221/ HOI	0.3125	SGI221	−0.1487	|SGI221|/ (|SGI221| + TP2)	0.2412
HIF311	0.2405	HIF311/ HOI	0.1342	SGI311	0.0201	|SGI311|/ (|SGI311| + TP3)	0.0413
HIF312	0.8255	HIF312/ HOI	0.4607	SGI312	−0.0234	|SGI312|/ (|SGI312| + TP3)	0.0476
HIF321	0.3505	HIF321/ HOI	0.1956	SGI321	0.0371	|SGI321|/ (|SGI321| + TP3)	0.0735

The values related to arc lengths may be obtained according to table 11 and table 12.

Sixth optical embodiment (Reference wavelength = 555 nm)						
ARE	1/2(HEP)	ARE value	ARE − 1/2(HEP)	2(ARE/HEP) %	TP	ARE/TP (%)
11	0.546	0.598	0.052	109.49%	0.468	127.80%
12	0.500	0.506	0.005	101.06%	0.468	108.03%
21	0.492	0.528	0.036	107.37%	0.349	151.10%
22	0.546	0.572	0.026	104.78%	0.349	163.78%
31	0.546	0.548	0.002	100.36%	0.559	98.04%
32	0.546	0.550	0.004	100.80%	0.559	98.47%

-continued

Sixth optical embodiment (Reference wavelength = 555 nm)						
ARS	EHD	ARS value	ARS − EHD	(ARS/EHD) %	TP	ARS/TP (%)
11	0.640	0.739	0.099	115.54%	0.468	158.03%
12	0.500	0.506	0.005	101.06%	0.468	108.03%
21	0.492	0.528	0.036	107.37%	0.349	151.10%

-continued

Sixth optical embodiment (Reference wavelength = 555 nm)						
22	0.706	0.750	0.044	106.28%	0.349	214.72%
31	1.118	1.135	0.017	101.49%	0.559	203.04%
32	1.358	1.489	0.131	109.69%	0.559	266.34%

The optical image capturing module **1** in the present invention may be applied to one of an electronic portable device, an electronic wearable device, an electronic monitoring device, an electronic information device, an electronic communication device, a machine vision device, a vehicle electronic device, and combinations thereof.

Specifically, the optical image capturing module in the present invention may be one of an electronic portable device, an electronic wearable device, an electronic monitoring device, an electronic information device, an electronic communication device, a machine vision device, a vehicle electronic device, and combinations thereof. Moreover, required space may be minimized and visible areas of the screen may be increased by using different numbers of lens assemblies depending on requirements.

Please refer to FIG. **34** which illustrates the optical image capturing module **712** and the optical image capturing module **714** in the present invention applied to a mobile communication device **71** (Smart Phone). FIG. **35** illustrates the optical image capturing module **722** in the present invention applied to a mobile information device **72** (Notebook). FIG. **36** illustrates the optical image capturing module **732** in the present invention applied to a smart watch **73**. FIG. **37** illustrates the optical image capturing module **742** in the present invention applied to a smart hat **74**. FIG. **38** illustrates the optical image capturing module **752** in the present invention applied to a safety monitoring device **75** (IP Cam). FIG. **39** illustrates the optical image capturing module **762** in the present invention applied to a vehicle imaging device **76**. FIG. **40** illustrates the optical image capturing module **772** in the present invention applied to a unmanned aircraft device **77**. FIG. **41** illustrates the optical image capturing module **782** in the present invention applied to an extreme sport imaging device **78**.

In addition, the present invention further provides a manufacturing method of an optical image capturing module, as shown in FIG. **41**, which may include the following steps:

S**101**: disposing a circuit assembly **100** and the circuit assembly **100** including a circuit substrate **120**, a plurality of image sensor elements **140**, and a plurality of signal transmission elements **160**;

S**102**: electrically connecting the plurality of signal transmission elements **160** between the plurality of circuit contacts **122** on the circuit substrate **120** and the plurality of image contacts **122** on a second surface **144** of each of the image sensor elements **140**;

S**103**: forming a multi-lens frame **180** integrally, which covers the multi-lens frame **180** on the circuit substrate **120** and the image sensor elements **140**, embedding a part of the signal transmission elements **160** in the multi-lens frame **180**, the other part of the signal transmission elements **160** being surrounded by the multi-lens frame **180**, and forming a plurality of light channels **182** on a sensing surface **1441** of the second surface **144** corresponding to each of the image sensor elements **140**;

S**104**: disposing a lens assembly **200**, which includes a plurality of lens bases **220** and a plurality of fixed-focus lens assemblies **230**;

S**105**: making the lens base **220** with an opaque material and forming an accommodating hole **2201** on the lens base **220** which passes through two ends of the lens base **220** in such a way that the lens base **220** becomes a hollow shape;

S**106**: disposing the lens bases **220** on the multi-lens frame **180** to connect the accommodating hole **2201** with the light channel **182**;

S**107**: disposing at least two lenses **2401** with refractive power in each of the fixed-focus lens assemblies **230** and making each of the fixed-focus lens assemblies **230** satisfy the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0 \leq 2(ARE/HEP) \leq 2.0;$$

In the conditions above, f is a focal length of the fixed-focus lens assembly **230**. HEP is the entrance pupil diameter of the fixed-focus lens assembly **230**. HAF is the half maximum angle of view of the fixed-focus lens assembly **230**. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base **220** perpendicular to an optical axis of the fixed-focus lens assembly **230**. PhiA is the maximum effective diameter of the fixed-focus lens assembly **230** nearest to a lens **2401** surface of an image plane. ARE is the arc length along an outline of the lens **2401** surface, starting from an intersection point of any lens **2401** surface of any lens **2401** and the optical axis in the fixed-focus lens assembly **230**, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

S**108**: disposing each of the fixed-focus lens assemblies **230** on each of the lens bases **220** and positioning each of the fixed-focus lens assemblies in the accommodating hole **2201**; and

S**109**: adjusting the image planes of each of the fixed-focus lens assemblies **230** of the lens assembly **200** to make the image plane of each of the fixed-focus lens assemblies **230** of the lens assembly **200** position on the sensing surface **1441** of each of the image sensor elements **140**, and to make the optical axis of each of the fixed-focus lens assemblies **230** overlap with a central normal line of the sensing surface **1441**.

Specifically, by employing S**101** and S**109**, smoothness is ensured with the feature of the multi-lens frame **180** manufactured integrally. Through the manufacturing process of AA (Active Alignment), in any step from S**101** to S**110**, the relative positions between each of the elements may be adjusted, including the circuit substrate **120**, the image sensor elements **140**, the lens base **220**, the plurality of fixed-focus lens assemblies **230**, and the optical image capturing module **10**. This allows light to be able to pass through each of the fixed-focus lens assemblies **230** in the accommodating hole **2201**, pass through the light channel **182**, and be emitted to the sensing surface **1441**. The image planes of each of the fixed-focus lens assemblies **230** may be disposed on the sensing surface **1441**. An optical axis of each of the fixed-focus lens assemblies **230** may overlap the central normal line of the sensing surface **1441** to ensure image quality.

Please refer to FIG. **2** to FIG. **7** and FIG. **42** to FIG. **44**. The present invention further provides an optical image capturing module **10** including a circuit assembly, a lens assembly **200**, and a multi-lens outer frame **190**. The lens assembly **100** includes a circuit substrate **120**, a plurality of image sensor elements **140**, a plurality of signal transmission elements **160**. The lens assembly **200** may include a plurality of lens bases **220** and a plurality of fixed-focus lens assemblies **230**.

The circuit substrate **120** may include a plurality of circuit contacts **120**. Each of the image sensor elements **140** may include a first surface **142** and a second surface **144**. LS is a maximum value of a minimum side length of an outer periphery of the image sensor elements **140** perpendicular to the optical axis on the surface. The first surface **142** may be connected to the circuit substrate **120**. The second surface **144** may have a sensing surface **1441**. The plurality of signal transmission elements **160** may be electrically connected between the plurality of circuit contacts **122** on the circuit substrate **120** and each of the plurality of image contacts **140** of each of the image sensor elements **146**.

The plurality of lens bases **220** may be made of opaque material and have an accommodating hole **2201** passing through two ends of the lens bases **220** so that the lens bases **220** become hollow, and the lens bases **220** may be disposed on the circuit substrate **120**. In an embodiment, the multi-lens frame **180** may be disposed on the circuit substrate **120**, and then the lens base **220** may be disposed on the multi-lens frame **180** and the circuit substrate **120**.

Each of the fixed-focus lens assemblies **230** may have at least two lenses **2401** with refractive power, be disposed on the lens base **220**, and be positioned in the accommodating hole **2201**. The image planes of each of the fixed-focus lens assemblies **230** may be disposed on the sensing surface **1441**. An optical axis of each of the fixed-focus lens assemblies **230** may overlap the central normal line of the sensing surface **1441** in such a way that light is able to pass through each of the fixed-focus lens assemblies **230** in the accommodating hole **2201**, pass through the light channel **182**, and be emitted to the sensing surface **1441** to ensure image quality. In addition, PhiB denotes the maximum diameter of the image side surface of the lens nearest to the image plane in each of the fixed-focus lens assemblies **230**. PhiA, also called the optical exit pupil, denotes a maximum effective diameter of the image side surface of the lens nearest to the image plane (image space) in each of the fixed-focus lens assemblies **230**.

In addition, each of the lens bases **220** may respectively be fixed to the multi-lens outer frame **190** in order to form a whole body of the optical image capturing module **10**. This may make the structure of the overall optical image capturing module **10** more steady and protect the circuit assembly **100** and the lens assembly **200** from impact and dust.

The fixed-focus lens assembly **230** further satisfies the following conditions:

$$1.0 \le f/HEP \le 10.0;$$

$$0\ \text{deg} < HAF \le 150\ \text{deg};$$

$$0\ \text{mm} < PhiD \le 18\ \text{mm};$$

$$0 < PhiA/PhiD \le 0.99;\ \text{and}$$

$$0 \le 2(ARE/HEP) \le 2.0;$$

Specifically, f is the focal length of the fixed-focus lens assembly **230**. HEP is the entrance pupil diameter of the fixed-focus lens assembly **230**. HAF is the half maximum angle of view of the fixed-focus lens assembly **230**. PhiD is the maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly **230**. PhiA is the maximum effective diameter of the fixed-focus lens assembly **230** nearest to a lens surface of the image plane. ARE is the arc length IS along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly **230**, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

Moreover, in each of the embodiments and the manufacturing method, each of the lens assemblies included in the optical image capturing module provided by the present invention is individually packaged. For example, the fixed-focus lens assemblies are individually packaged so as to realize their respective functions and equip themselves with a fine imaging quality.

The above description is merely illustrative rather than restrictive. Any equivalent modification or alteration without departing from the spirit and scope of the present invention should be included in the appended claims.

What is claimed is:

1. An optical image capturing module, comprising:

a circuit assembly, comprising:

a circuit substrate, comprising a plurality of circuit contacts;

a plurality of image sensor elements, each of the image sensor elements comprising a first surface and a second surface, the first surface connected to the circuit substrate, and the second surface having a sensing surface and a plurality of image contacts;

a plurality of signal transmission elements, electrically connected between the plurality of circuit contacts on the circuit substrate and each of the plurality of image contacts of each of the image sensor elements; and

a multi-lens frame, manufactured integrally and covered on the circuit substrate and the image sensor elements, a part of the signal transmission elements embedded in the multi-lens frame, the other part of the signal transmission elements surrounded by the multi-lens frame, and positions corresponding to the sensing surface of the plurality of image sensor elements having a plurality of light channels; and

a lens assembly, comprising

a plurality of lens bases, each of the lens bases made of an opaque material and having an accommodating hole passing through two ends of the lens base in such a way that the lens base becomes a hollow shape, and each of the lens bases disposed on the multi-lens frame in such a way that the accommodating hole is connected to the light channel; and

a plurality of fixed-focus lens assemblies, each of the fixed-focus lens assemblies having at least two lenses with refractive power, disposed on a respective one of the lens bases and positioned in the accommodating hole, an image plane of each of the fixed-focus lens assemblies positioned on the sensing surface, and an optical axis of each of the fixed-focus lens assemblies overlapping a central normal line of the sensing surface in such a way that light is able to pass through each of the fixed-focus lens assemblies in the accommodating hole, pass through the light channel, and be emitted to the sensing surface;

wherein, the fixed-focus lens assembly further satisfies the following conditions:

$$1.0 \le f/HEP \le 10.0;$$

$$0\,\text{deg} < HAF \le 150\,\text{deg};$$

$$0\,\text{mm} < PhiD \le 18\,\text{mm};$$

$$0 < PhiA/PhiD \le 0.99; \text{ and}$$

$$0.9 \le 2(ARE/HEP) \le 2.0;$$

wherein, f is a focal length of the fixed-focus lens assembly; HEP is an entrance pupil diameter of the fixed-focus lens assembly; HAF is a half maximum angle of view of the fixed-focus lens assembly; PhiD is a maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly;

PhiA is a maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of the image plane; ARE is an arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

2. The optical image capturing module according to claim **1**, wherein each of the lens bases comprises a lens barrel and a lens holder; the lens barrel has an upper hole which passes through two ends of the lens barrel, and the lens holder has a lower hole which passes through two ends of the lens holder; the lens barrel is disposed in the lens holder and positioned in the lower hole in such a way that the upper hole and the lower hole are connected to constitute the accommodating hole; the lens holder is fixed on the multi-lens frame in such a way that a respective one of the image sensor elements is positioned in the lower hole; the upper hole of the lens barrel faces the sensing surface of the respective one of the image sensor elements; the fixed-focus lens assembly is disposed in the lens barrel and is positioned in the upper hole; and PhiD is a maximum value of a minimum side length of an outer periphery of the lens holder perpendicular to the optical axis of the fixed-focus lens assembly.

3. The optical image capturing module according to claim **2**, further comprising an IR cut filter disposed in the lens barrel or the lens holder and positioned on a respective one of the image sensor elements.

4. The optical image capturing module according to claim **1**, further comprising at least one data transmission line electrically connected to the circuit substrate and transmitting a plurality of sensing signals generated from each of the plurality of image sensor elements.

5. The optical image capturing module according to claim **1**, wherein the plurality of image sensor elements sense a plurality of color images.

6. The optical image capturing module according to claim **1**, wherein at least one of the image sensor elements senses a plurality of black-and-white images and at least one of the image sensor elements senses a plurality of color images.

7. The optical image capturing module according to claim **1**, further comprising an IR cut filter disposed in one of the lens bases, positioned in the accommodating hole, and located on a respective one of the image sensor elements.

8. The optical image capturing module according to claim **1**, wherein the lens base comprises a filter holder, the filter holder has a filter hole which passes through two ends of the filter holder, an IR cut filter is disposed in the filter holder and positioned in the filter hole, and the filter holder corresponds to positions of the plurality of light channels and is disposed on the multi-lens frame in such a way that the IR cut filter is positioned on a respective one of the image sensor elements.

9. The optical image capturing module according to claim **8**, wherein the lens base comprises a lens barrel and a lens holder; the lens barrel has an upper hole which passes through two ends of the lens barrel, the lens holder has a lower hole which passes through two ends of the lens holder, and the lens barrel is disposed in the lens holder and positioned in the lower hole; the lens holder is fixed on the filter holder, and the lower hole, the upper hole, and the filter hole are connected to constitute the accommodating hole in such a way that a respective one of the image sensor elements is positioned in the filter hole, and the upper hole of the lens barrel faces the sensing surface of the respective one of the image sensor elements; in addition, the fixed-focus lens assembly is disposed in the lens barrel and positioned in the upper hole.

10. The optical image capturing module according to claim **9**, wherein the following condition is satisfied:

$$0 < (TH1+TH2)/HOI \le 0.95;$$

wherein, TH1 is a maximum thickness of the lens holder; TH2 is a minimum thickness of the lens barrel; HOI is a maximum image height perpendicular to the optical axis on the image plane.

11. The optical image capturing module according to claim **9**, wherein the following condition is satisfied:

$$0\,\text{mm} < TH1+TH2 \le 1.5\,\text{mm};$$

wherein, TH1 is a maximum thickness of the lens holder; TH2 is a minimum thickness of the lens barrel.

12. The optical image capturing module according to claim **9**, wherein the following condition is satisfied:

$$0 < (TH1+TH2)/HOI \le 0.95;$$

wherein, TH1 is a maximum thickness of the lens holder; TH2 is a minimum thickness of the lens barrel; HOI is a maximum image height perpendicular to the optical axis on the image plane.

13. The optical image capturing module according to claim **1**, wherein materials of the multi-lens frame comprise any one of metal, conducting material, and alloy, or any combination thereof.

14. The optical image capturing module according to claim **1**, wherein materials of the multi-lens frame comprise any one of thermoplastic resin, plastic used for industries, and insulating material, or any combination thereof.

15. The optical image capturing module according to claim **1**, wherein the multi-lens frame comprises a plurality of camera lens holders, each of the camera lens holders has the light channel and a central axis, and a distance between the central axes of adjacent camera lens holders is a value between 2 mm and 200 mm.

16. The optical image capturing module according to claim **1**, wherein a reflectance of the multi-lens frame is less than 5% in a light wavelength range of 435-660 nm.

17. The optical image capturing module according to claim **1**, wherein the multi-lens frame has an outer surface, a first inner surface, and a second inner surface; the outer surface extends from a margin of the circuit substrate, and has a tilted angle α with the central normal line of the sensing surface, and α is a value between 1° to 30°; the first inner surface is an inner surface of the light channel, the first inner surface has a tilted angle β with the central normal line of the sensing surface, and β is a value between 1° to 45°; the second inner surface extends from the image sensing elements to the light channel, and has a tilted angle γ with the central normal line of the sensing surface, and γ is a value between 1° to 3°.

18. The optical image capturing module according to claim **1**, wherein the plurality of fixed-focus lens assemblies comprise a first lens assembly and a second lens assembly, and a field of view (FOV) of the second lens assembly is larger than that of the first lens assembly.

19. The optical image capturing module according to claim **1**, wherein the plurality of fixed-focus lens assemblies comprise a first lens assembly and a second lens assembly, and a focal length of the first lens assembly is larger than that of the second lens assembly.

20. The optical image capturing module according to claim **1**, wherein the optical image capturing module has at least three fixed-focus lens assemblies, comprising a first lens assembly, a second lens assembly, and a third lens assembly; a field of view (FOV) of the second lens assembly is larger than that of the first lens assembly, the field of view (FOV) of the second lens assembly is larger than 46°, and each of the plurality of image sensor elements correspondingly receiving lights from the first lens assembly and the second lens assembly senses a plurality of color images.

21. The optical image capturing module according to claim **1**, wherein the optical image capturing module has at least three fixed-focus lens assemblies, comprising a first lens assembly, a second lens assembly, and a third lens assembly; a focal length of the first lens assembly is larger than that of the second lens assembly, and each of the plurality of image sensor elements correspondingly receiving lights from the first lens assembly and the second lens assembly senses a plurality of color images.

22. The optical image capturing module according to claim **1**, wherein the following condition is satisfied:

wherein 0.9≤ARS/EHD≤2.0; wherein, ARS is an arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a maximum effective half diameter point of the lens surface; EHD is a maximum effective half diameter of any surface of any lens in the fixed-focus lens assembly.

23. The optical image capturing module according to claim **1**, wherein the following conditions are satisfied:

PLTA≤100 μm; PSTA≤100 μm; NLTA≤100 μm; and NSTA≤100 μm; SLTA≤100 μm; SSTA≤100 μm;

wherein, HOI is first defined as a maximum image height perpendicular to the optical axis on the image plane; PLTA is a lateral aberration of the longest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; PSTA is a lateral aberration of the shortest operation wavelength of visible light of a positive tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; NLTA is a lateral aberration of the longest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; NSTA is a lateral aberration of the shortest operation wavelength of visible light of a negative tangential ray fan aberration of the optical image capturing module passing through a margin of an entrance pupil and incident at the image plane by 0.7 HOI; SLTA is a lateral aberration of the longest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI; SSTA is a lateral aberration of the shortest operation wavelength of visible light of a sagittal ray fan aberration of the optical image capturing module passing through the margin of the entrance pupil and incident at the image plane by 0.7 HOI.

24. The optical image capturing module according to claim **1**, wherein the fixed-focus lens assembly comprises four lenses with refractive power, which are a first lens, a second lens, a third lens, and a fourth lens sequentially displayed from an object side surface to an image side surface, and the fixed-focus lens assembly satisfies the following condition:

$$0.1 \leq InTL/HOS \leq 0.95;$$

wherein, HOS is a distance on the optical axis from an object side surface of the first lens to the image plane; InTL is a distance on the optical axis from an object side surface of the first lens to an image side surface of the fourth lens.

25. The optical image capturing module according to claim **1**, wherein the fixed-focus lens assembly comprises five lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, and a fifth lens sequentially displayed from an object side surface to an image side surface, and the fixed-focus lens assembly satisfies the following condition:

$$0.1 \leq InTL/HOS \leq 0.95;$$

wherein, HOS is a distance on the optical axis from an object side surface of the first lens to the image plane; InTL is a distance on the optical axis from an object side surface of the first lens to an image side surface of the fifth lens.

26. The optical image capturing module according to claim **1**, wherein the fixed-focus lens assembly comprises six lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, a fifth lens, and a sixth lens sequentially displayed from an object side surface to an image side surface, and the fixed-focus lens assembly satisfies the following condition:

$$0.1 \leq InTL/HOS \leq 0.95;$$

wherein, HOS is a distance on the optical axis from an object side surface of the first lens to the image plane; InTL is a distance on the optical axis from an object side surface of the first lens to an image side surface of the sixth lens.

27. The optical image capturing module according to claim **1**, wherein the fixed-focus lens assembly comprises seven lenses with refractive power, which are a first lens, a second lens, a third lens, a four lens, a fifth lens, a sixth lens, and a seventh lens sequentially displayed from an object side surface to an image side surface, and the fixed-focus lens assembly satisfies the following condition:

$$0.1 \leq InTL/HOS \leq 0.95;$$

wherein, HOS is a distance on the optical axis from an object side surface of the first lens to the image plane; InTL is a distance on the optical axis from an object side surface of the first lens to an image side surface of the seventh lens.

28. The optical image capturing module according to claim 1, further comprising an aperture, and the aperture satisfies a following equation: 0.2≤InS/HOS≤1.1; wherein, InS is a distance from the aperture to the image plane on the optical axis; HOS is a distance on the optical axis from a lens surface of the fixed-focus lens assembly farthest from the image plane.

29. An optical image capturing module according to claim 1, applied to one of an electronic portable device, an electronic wearable device, an electronic monitoring device, an electronic information device, an electronic communication device, a machine vision device, a vehicle electronic device, and combinations thereof.

30. A manufacturing method of an optical image capturing module, comprising:

disposing a circuit assembly comprising a circuit substrate, a plurality of image sensor elements and a plurality of signal transmission elements;

electrically connecting the plurality of signal transmission elements between the plurality of circuit contacts on the circuit substrate and the plurality of image contacts on a second surface of each of the image sensor elements;

forming a multi-lens frame on the circuit assembly integrally, which covers the multi-lens frame on the circuit substrate and the image sensor elements, embedding a part of the signal transmission elements in the multi-lens frame, the other part of the signal transmission elements surrounded by the multi-lens frame, and forming a plurality of light channels on a sensing surface of the second surface corresponding to each of the image sensor elements;

disposing a lens assembly, which comprises a lens base and a plurality of fixed-focus lens assemblies;

making the lens base with an opaque material and forming an accommodating hole on each of the lens bases which passes through two ends of the lens base in such a way that the lens base becomes a hollow shape;

disposing the lens base on the multi-lens frame to connect the accommodating hole with the light channel;

disposing at least two lenses with refractive power in each of the fixed-focus lens assemblies and making each of the fixed-focus lens assemblies satisfy the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0 \leq 2(ARE/HEP) \leq 2.0;$$

in the conditions above, f is a focal length of the fixed-focus lens assembly; HEP is an entrance pupil diameter of the fixed-focus lens assembly; HAF is a half maximum angle of view of the fixed-focus lens assembly; PhiD is a maximum value of a minimum side length of an outer periphery of the lens base perpendicular to an optical axis of the fixed-focus lens assembly; PhiA is a maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of an image plane; ARE is an arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter;

disposing each of the fixed-focus lens assemblies on the lens base and positioning the fixed-focus lens assembly in the accommodating hole;

adjusting the image planes of each of the fixed-focus lens assemblies of the lens assembly to make the image plane of each of the fixed-focus lens assemblies of the lens assembly respectively position on the sensing surface of each of the image sensor elements, and to make the optical axis of each of the fixed-focus lens assemblies overlap with a central normal line of the sensing surface.

31. An optical image capturing module, comprising:

a circuit assembly, comprising:

a circuit substrate, comprising a plurality of circuit contacts;

a plurality of image sensor elements, each of the image sensor elements comprising a first surface and a second surface, the first surface connected to the circuit substrate, and the second surface having a sensing surface and a plurality of image contacts;

a plurality of signal transmission elements, electrically connected between the plurality of circuit contacts on the circuit substrate and each of the plurality of image contacts of each of the image sensor elements; and

a lens assembly, comprising:

a plurality of lens bases, each of the lens bases made of an opaque material and having an accommodating hole passing through two ends of the lens base in such a way that the lens base become a hollow shape, and each of the lens bases disposed on the circuit substrate; and

a plurality of fixed-focus lens assemblies, each of the fixed-focus lens assemblies having at least two lenses with refractive power, disposed on the lens base and positioned in the accommodating hole, an image plane of each of the fixed-focus lens assemblies positioned on the sensing surface, and an optical axis of each of the fixed-focus lens assemblies overlapping a central normal line of the sensing surface in such a way that light is able to pass through each of the fixed-focus lens assemblies in the accommodating hole and be emitted to the sensing surface; and

a multi-lens outer frame, wherein each of the lens bases is respectively fixed to the multi-lens outer frame in order to form a whole body;

wherein, the fixed-focus lens assembly further satisfies the following conditions:

$$1.0 \leq f/HEP \leq 10.0;$$

$$0 \text{ deg} < HAF \leq 150 \text{ deg};$$

$$0 \text{ mm} < PhiD \leq 18 \text{ mm};$$

$$0 < PhiA/PhiD \leq 0.99; \text{ and}$$

$$0 \leq 2(ARE/HEP) \leq 2.0;$$

$$0.9 < 2(ARE/HEP) < 2.0;$$

wherein, f is a focal length of the fixed-focus lens assembly; HEP is an entrance pupil diameter of the fixed-focus lens assembly; HAF is a half maximum angle of view of the fixed-focus lens assembly; PhiD is a maximum value of a minimum side length of an outer periphery of the lens base perpendicular to the optical axis of the fixed-focus lens assembly; PhiA is a maximum effective diameter of the fixed-focus lens assembly nearest to a lens surface of the image plane; ARE is an arc length along an outline of the lens surface, starting from an intersection point of any lens surface of any lens and the optical axis in the fixed-focus lens assembly, and ending at a point with a vertical height which is a distance from the optical axis to half the entrance pupil diameter.

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